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ARE RAILROADS PUBLIC ENEMIES?

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(SECOND PAPER.)

SINCE a paper printed in the March "Popular Science Monthly" was in type, the Interstate Commerce bill has become law. This law establishes a Commission, to whose decision is now committed the regulation of the railways as to their relations with the individual shipper. Since the law permits the railway to apply to the Commission for leave to discriminate as to hauls and shippers,* or otherwise to pursue the tenor of which experience has taught the expediency, it need not prevent a final ventilation of the remainder contents of Mr. Hudson's scrap-book against railroads, nor impose upon us the technical discussion hereafter reserved for the Commission itself. Our last paper left over for consideration:

I. Discriminations by long haul and short haul.

II. Stock-watering (which Mr. Hudson, however, prefers to nominate "the fictitious element in railway policy"); and—

III. "Eminent domain" (that is to say, a modicum of the power of the State, by acceptance of a grant of which a railroad company is understood to accept the burden of certain public obligations).

It should be premised, perhaps, even at the risk of becoming elementary, that one railroad company is not all railroads. Such syllogisms as: 1. A railway corporation which charges more for a long haul than a short haul is a public enemy. 2. The A B and C D Railroad charges more for a long haul than a short haul; *ergo*, all railroads are public enemies—or, 1. A corporation which "waters" its capital stock is a public enemy. 2. The E F and G H Railroad once "watered" its stock; *ergo*, all railroads are public enemies—and the like, are

* Section 4.

mere replica of the schoolboy fallacy: Food is necessary to life: Corn is food; *ergo*, corn is necessary to life (in which the undistributed middle is supposed to elude the urchin logician), and are altogether beside adult discussion of economical questions. But let Mr. Hudson's processes be waived while we address ourselves to the material of the charges he pastes—and I assume that he pastes them correctly—in his scrap-book:

I. The Long and Short Haul.—There certainly never arose in practical railway operation a situation wherein a railway company was solicitous to charge less money for doing more work and to pay its own expenses meanwhile. But in practical railway policy a difference between the cost and the value of certain business to the company might, and sometimes does, arise which appeals to the company's instinct of self-preservation too despotically to be disregarded. A railway company, which has for long years acceptably served its local and through patrons, finds itself suddenly paralleled by a rival company, serving all or some of the same localities not only, but prepared as a part of its (the second comer's) investment to undergo the expense of "cutting" rates, and so to supplant the first comer by offering to take business for less than the actual expense of doing it, even though some of the competing points are farther distant from the common terminals of the paralleled line than the actual length of the roads. Under such circumstances, the value of all of its original business it could retain would be clearly of more value to the first company than the then present cost of doing it: and the result would, of course, by every law of human economy or of human nature, be that the first company would either anticipate or respond to the "cut." The effect in either case would be to cheapen tariffs to the shipper—to the people. But Mr. Hudson, at this moment, does not care for the people. Later on he will take up the cudgels for them, but just now he kindly holds a brief for the railroads. He thinks it shameful that deserving and hard-working railroads should be obliged to take long hauls for actually less than they are legally entitled to charge for short hauls—for much smaller distances. Mr. Hudson has no objection, of course, to one of his fellow-countrymen riding from New York to Chicago for five dollars, or shipping live-stock from Toledo to Buffalo at one dollar a car-load during a railway war. (Or, if he should still remember the poor public, it will be not the poor public who ride a thousand miles for five dollars, or at the rate of half a cent a mile, but the poor public who commonly ride one hundred and sixty-seven miles for five dollars, thereby being compelled to either walk or pay the legal mileage of three cents which the company is allowed by law to charge.) But should the railway companies find that carrying passengers from New York to Chicago for five dollars, or cattle from Toledo to Buffalo at one dollar a car-load does not pay—that by making such rates they are robbing—not the public at large, perhaps, but their own stock-

holders, and depreciating their own securities; and should, since no other offers, the railway companies themselves propose becoming their own reformers, and so evolve the idea of pool commissions whereby each company might yet live and enjoy the franchises the people had given it—when this new aspect presents itself, we say—Mr. Hudson shifts back to his original brief, and finds the railways once again the rampant enemies of his corraled clients—the people. But on taking up his brief our unfortunate Mr. Hudson finds himself once more out of court, confronted with the terrible truth that under the pool the rates have not only been raised but have actually fallen below a legalized minimum, and his occupation and standpoint again departed. A comparison of tariffs before and after the local pool systems existing at the passage of the Interstate Commerce bill of course can not be attempted here. But it will be found to correspond everywhere throughout the country to the following figures taken at random. (Of course the tariffs need not be compared with figures existing at the inception of railroads, or at intervals of ten years since, because everybody knows—who knows anything, or who reflects upon the subject at all—that the history of the railway has been the history of the tariff reductions upon every commodity, every product of human manufacture or yield of Nature):

HAUL.	Rates before establishment of pool (per 100 lbs.).	Rates after establishment of pool (per 100 lbs.).
Omaha to Kansas City or Denver, first class	$2.40	$2.10
Omaha to Kansas City or Denver, fourth class	1.40	1.15
Omaha to Salt Lake City, first class	3.30	3.00
Omaha to Salt Lake City, fourth class	3.00	1.55
*New York to Pittsburg, fourth class	.30	.20
*New York to Altoona, fourth class	.28	.17

All the above being non-competitive or "short-haul" points (since Kansas City, Denver, and Salt Lake can only be reached from Omaha—or the points Pittsburg or Altoona can only be reached from New York—by land transportation), there was no legal, certainly no natural, reason (according to Mr. Hudson) why the mere technical fact of a pool should have lowered rates. If, as Mr. Hudson asserts, railways are selfish, grasping, lawless monopolies, enemies of the republic and devourers of the people, there was, on the contrary, every reason why, when three or four railways pooled their issues and monopolized all the possible rail connections to that point, rates should be as high as, if not higher than before. Certainly there is no reason, legal or natural, why, to a point like Altoona, among the mountains, to which but a single through line has had the courage or the charter to climb (and that one, according to Mr. Hudson, one of the most grasping of all his category of grasping monopolies), freights should be lower after the organization

* I take these last two quotations from Mr. E. P. Alexander's "Railway Practice; its Principles and Suggested Reforms reviewed," New York, 1887.

of a pool than they were before. The explanation appears, however, as the demonstration proceeds and the technical meaning of the terms "long haul" and "short haul" becomes self-evident. Clearly the points we have named become "short hauls" as against (for example) San Francisco, the haul to which is therefore called a "long haul." Now, in establishing rates to San Francisco, certainly it is very apparent that the railroads which have pooled to Salt Lake City or Denver must take a new factor into the account, for San Francisco has a most excellent water communication with the entire world, and is perfectly independent of railways, monopolies or otherwise. In other words, it is Nature and not railroad corporations that have discriminated against Denver and Salt Lake City, and in favor of San Francisco, by making it a commercial fact that (since water is cheaper than land transportation) San Francisco is actually nearer New York than Denver or Salt Lake City. The fact is that—so long as railway rates are regulated by geography—however distorted they may appear to the non-expert, the substitution of arbitrary for geographical rules in framing a tariff would result in rendering them still more distorted and uneven. And if the railways, pooled or unpooled, charge proportionately less rates to San Francisco than to Denver or Altoona or Salt Lake City, the higher power that has ordered it is the irresistible power of Nature. To what lengths of invective and diatribe Mr. Hudson and his kind would proceed, did Nature and geography "pool" with the railways, it is amusing to speculate; but the fact—which oppresses the railway company at present, and imposes upon it the necessity of accommodating its rates to Nature (since Nature will not accommodate herself to the railways)—is that no pool can be made with the ocean, which charges nothing to the sons of men who plow its bosom with their ships, and which is at no expense to keep itself in repair. For, let it be always remembered, in discussing these and like questions, a railroad is not, *per se*, a means of transportation. Such a definition is very far from being definitive by exclusion, as a definition ought to be. A railroad is a prepared and exclusive highway for traffic by means of the motive power of the locomotive engine, and is available only where locomotives can be used. There are still the foot-path, the bridle-path, the wagon-road, the ocean, the river, the canal, with which it must compete. There is still the inclined plane, with which (for the down-grade, certainly) no locomotive even can compete. And so, even were railway companies the terrible affairs, the grasping monopolies, the enemies of the human race, which Mr. Hudson asserts them, they are only so because the human race uses them, if it uses them at all, in preference to other means of transportation. Should Mr. Hudson induce his *clientèle* to discontinue their preference, the fact might be different; but in order to accept Mr. Hudson's conclusion (which, be it remarked again, is not the rule of the Interstate Commerce Law) that railways are public enemies because their tariffs sometimes are greater

for the long than the short haul, we must primarily assume the two propositions: first, that the public are not at liberty to use any other means of transportation than the railways; and, second, that there is no such thing as competition. Does Mr. Hudson desire us to accept these propositions, or think that he has established them? What else does he mean by such a paragraph as this (page 40): "While the force of competition causes the railways to accept moderate or even narrow profits on the Western grain-traffic, the absence of that force allows them to collect what, by comparison, are shown to be exorbitant profits on the grain shipped by the farmers of the Eastern or Middle States." As a matter of fact, the figures actually show that it is combination, not competition, which has reduced the rates charged by the enemies of the republic and forced them to "accept moderate or even narrow profits." Surely, Mr. Hudson does not wish us to believe him guilty of catering to the general public by misstatements of fact in cases with which, from the least apparent foothold for grievance, he assumes such fluent familiarity. And yet, what else can we conclude from his retort to Mr. Fink's calm statement before the Senate Committee on Railroads in 1883, to the general effect above stated (viz., that geographical and not arbitrary conditions controlled pool-rates) in which he happens to mention Winona (using that town, as we have used Denver or Salt Lake City above, as an instance of a "short-haul" point)? "Why," says Mr. Hudson (page 161), "the road, if built for Winona, should have stopped at that place and given its exclusive attention to the transportation interests of that town." And, if this could be exceeded in artless incapacity, he meets Mr. Alexander's statement (page 162) that "no railway has ever raised its local charges to meet the loss caused by lowering its through rates," by the following: "When railway rates have been reduced fifty per cent on through traffic within the last ten years, and local rates have virtually remained unchanged, the burden of the local shippers has been practically doubled, no matter what sophistry is used to conceal the fact." Surely, it needs no expert in railway affairs to detect that the "sophistry" just here is not Mr. Alexander's. Lawyers of a certain grade sometimes talk to juries in this vein, but they are shrewd enough to know their jury pretty well before attempting it. An industry that employs seven or eight thousand millions of capital in these United States ought, one would say, to be reasonably suspected of employing brains here and there—certainly ought not rashly to be assumed to neglect the entire remainder of its continental field (to say nothing of the keeping of its own books), in order to concentrate its entire energies upon the commercial destruction of a single village! There has yet to be discovered, I suppose, a human institution in whose workings there was not hardship or inequality somewhere. But Mr. Hudson has only, it seems to him, to select his hardship to demolish the entire railway system—his principle being, not the greatest good

to the greatest number, but the least good to the greatest number (or, possibly, the greatest good to the least number), so that the selected village is favored. But what else would this be, again, but a monopoly of commercial privileges; and how soon—did the railway or the railways adopt Mr. Hudson's suggestion and discriminate exclusively in favor of his village—before Mr. Hudson would be on his feet again with an entirely new compilation of grievances, demanding to know why this particular village was selected out of the entire continent to be so pre-eminently favored? Does not even Mr. Hudson begin to catch a glimpse of just how vast, how complicated, and inexhaustible this railway problem really is? But possibly he does not, for he says, You charge this village of B too much. No, we charge everybody according to geographical position; it saves us labor to do so, says Mr. Alexander. Well, anyhow, says Mr. Hudson, you lowered the rate to A, and did not lower the rate to B, and that's the act of a public enemy; and he straightway sits down and inflicts us with a book of 500 pages, of which the argument is (or ought to be, to be consistent) that A is not the public or even the republic, whereas B is both the one and the other. If Mr. Hudson will kindly turn to one of his own pages (in which possibly the mass of excerpta has bewildered him), he will be doubtless surprised to find (page 159) an admission that, astounding as it may seem, on a single trunk-line in a single year, as between the anti-pool rates of 1865 and the pool rates of 1882, a saving to the public, in freights alone, of $318,947,486,261 has been effected. But, having made the admission, he is ready to meet it after his kind. "This is an astonishing instance," he continues, "of giving away what the giver never owned or possessed; the fact is kept out of sight that the business of 1882 is the result of the progressive reduction of rates for many years, and could never have existed but for the reductions." Surely, the readers of "The Popular Science Monthly" have never witnessed quite such a wiping out of the laws of supply and demand as this! Mr. Hudson will have us believe that the people of the United States on the line of the given railroad would not have eaten and drunk, or purchased supplies, worn clothes or slept on beds, and that population itself for seventeen years would have suspended its rules—perhaps the laws of gravitation themselves have ceased—had not this railroad reduced its rates. But let us overlook any possible increase of population or of the wants or luxuries of a given territory in the space of twenty-two years, and consider this particular railway company as all railways. The argument will then remain as follows: Railways are public enemies because they are exorbitant in their charges. But figures show that their charges are constantly decreasing. Never mind that, says Mr. Hudson, if railways reduce their rates they only do so from the selfish motive of getting still more business. Most shippers over a railway would be contented if the railway would only charge them low rates. But Mr. Hudson (who, possibly, is not a shipper over

any line) will have none of their reduced rates unless they reduce them from the proper motive. After all, the act is nothing. It is the motive which must govern. And doubtless we could nowhere elicit a more virtuous, certainly nowhere a better specimen than this of Mr. Hudson's public-spirited argument against railroads, from this most exhaustive and most entertaining of scrap-books. "No matter what you do, if your 'eart is only true," says the old song. And so says Mr. Hudson to the railroads of this republic. But let it at least be remembered in their behalf that, even if they did it with selfish motives, the railways were themselves the first to attempt their own reformation. Railroads are and must remain built for the private emolument of their owners, and not for charitable purposes. They were not proof against the temptation of charging more money for a short haul to non-competitive points than for a long haul to competitive points in the struggle to live alongside of paralleling lines which the people themselves have chartered. But, when the pool removed this temptation by making all points non-competitive—although no law, human or divine, compelled them; they did voluntarily resist the temptation to pool at maximum rates—the rates not only fell, but became proportionate to cost of hauling, the competition remaining only as to those "long-haul" points in whose favor Nature has discriminated by establishing water communications. Mr. Hudson has, perhaps, read a great many books. He should not have omitted from among them the late Dr. Lieber's "Civil Liberty and Self-Government" (especially the chapter wherein is treated the principle of the "Freedom of Rivers"). Then, remembering that the United States has not only two ocean coast-lines, but great lakes and a system of navigable rivers more magnificent and more benign than that of any other country, he might possibly have perceived how—in his railway problem—so slight a consideration as our national geography might be at least as important a factor as a handful of selected individual hardships. Mr. Hudson does not relish the rates charged by our railway companies. He suggests no others, but is entirely clear, none the less, that they should be changed somehow. If rates are at present arranged upon a system, let us drop the system and make them arbitrary—according to Mr. Hudson's selection, if he would only agree to abide by it. If your present rates are robbing the people, low as they are—very well, lower them still more, and rob your stockholders. It is evident that Mr. Hudson, for one, is no stockholder. But are not our stockholders parcel of the people? And so the old impossibility of finding standpoint—or rather, the necessity of shifting his point of view with each newspaper-clipping he pastes in his scrap-book—renders Mr. Hudson everywhere specious, inconsistent and absurd; which leads us up to our second head.

II. Stock-Watering.—But, says Mr. Hudson, you can not really rob your stockholders, you know, because your stock is "water," and

your capitalization "fictitious." Let us see about this. Many a good cause and many a good man have been slain by an epigram. It was a *coup d'esprit* of Wall Street to call the increased capitalization by a corporation a "watering" of its stock; and the phrase has doubtless often done yeoman service in the transactions by which Wall Street lives and thrives. But the old syllogism must be accepted very peremptorily here if we are to admit—because corporations sometimes do increase their capital on paper—that all railway companies are public enemies. Nobody can defend, and nobody ought to attempt to defend, the pouring of pure water into the capital stock of a corporation. But there are some four hundred railroad companies in these United States; and Mr. Hudson, to sustain the charge of universal watering against railway companies, instances two capital cases. One of these was one of the most flagrant cases on record (it would be difficult, indeed, to find one more flagrant). It dates back some twelve years; was first held up to public criticism by a gentleman who, more than any other one man, is in receipt of Mr. Hudson's constant and most unqualified strictures everywhere else in Mr. Hudson's pages for his own career as a railroad president; moreover, this very case became the moving cause of legislation which forever prevented a repetition of the particular process by which this particular stock was "watered." As to the other case cited by Mr. Hudson, the "watering," according to his own figures, amounted to one third of its increased capital. But I doubt if any shipper of the line of that particular railroad, or any patron of the line who remembers its previous condition, will agree with Mr. Hudson that a betterment of one third at least did not accrue at about the time of the "watering." Suppose a zigzag line of railways operated by half a dozen petty corporations, requiring endless delays, a change of cars for passengers and a breaking of freight bulks between two of the most important terminals in the country—metamorphosed into a system of four through tracks to conserve the safety of life and property by separating freight and passenger service. Suppose the improvement marked by increased prosperity, not only of the line but of the territory it traversed—would there have been no betterment to capitalize, or would the capitalizing of this betterment be "water"? Would stockholders, in such a case, be apt to object to the company borrowing money to make their own stock more valuable? And which is Mr. Hudson's public just now, the public along the line of this improved railway, and who pay its tariffs; or the entire continent from Sandy Hook to the Golden Gate, from Canada to the Gulf of Mexico, for whom Mr. Hudson assumes to take up his parable? Another curious fact which Mr. Hudson may not be aware of (or if aware of, which he has inadvertently omitted to clip and paste in just here) is the fact that at present, in 1887, these two selected corporations are members of the same pool, serving respective but almost parallel territory at rates at least thirty-three per

cent lower than at the dates at which their recapitalizations occurred. Mr. Hudson's platitudes against "stock-watering," so long as he confines himself to platitudes and truisms merely, are perfectly safe. But when, in 1887, he prints the newspaper-clippings of 1872–'74, and moralizes therefrom, he can hardly complain if his public demur, not only to his antique instances, but to his general safety as a guide in the complicated questions with which he assumes to deal. I mention these two examples (which are now ancient history) not to suggest an excuse for them, but as showing how entirely superfluous Mr. Hudson's employment of them is; and how as a matter of fact the wrong, so far as the public is concerned, has been entirely neutralized by application of the pooling system. Other things being equal, there is no reason why a railroad should not capitalize its earnings by employing them for betterments, any more than that an individual should capitalize his by putting back his earnings into his business. Nor is it quite apparent that any moral dishonesty enters into the act of even capitalizing those betterments which Nature and the march of civilization bring, which I understand are called (just now) "the unearned increment." I do not remember that any company has so far been guilty of this particular sort of watering; but, had the early Dutch settlers of Manhattan Island built the present elevated railway, it is interesting to speculate what sin would have been committed against natural or moral law had their assigns in 1887 capitalized that structure, not at an approximate to its earning power at the date of its construction (in, say, 1666), but at a sum representative of its actual earning power in the later year. Neither am I aware by what mental processes one can insist on "unearned" increments at all, if by that popular term we mean the increase to one's property by the efforts or investments of one's neighbors. It is fashionable, I am aware, to say that if A's corner lot increases fifty per cent by reason of the purchase and improvement of adjoining lots by B, C, D, E, and F, that fifty percentage is A's unearned increment; but is A's foresight and shrewdness in investing in the corner lot aforesaid, when he might have placed his money elsewhere, to count for nothing? Are not brains a part of one's capital, and may not A's foresight and shrewdness have been and continued a considerable part of his capital or stock in trade or earning power? Assuming that Mr. Hudson does not contemplate the removal of cerebral inequality between man and man by due process of law, it might occur that whereas the rest of the alphabet had no confidence in the future of—let us say, a certain B and C Railroad—A might foresee a Pacific Railway, or a commercial development, or the bankruptcy of a competing line—which would make it valuable, and so might without sin buy up its stock at five cents on a dollar and in due time reap substantial rewards. And supposing even that A, by the transaction (or even by recapitalizing this same B and C Railroad), was ultimately enabled to accumulate one of those enormous fortunes

in which Mr. Hudson sees such peril to his republic, would even such a public calamity go to prove railways public enemies, or that any and all increase of capitalization was "stock-watering"? Doubtless improper practices will obtain with evil-minded men until the end of time. But if the enormous fortunes aforesaid have been accumulated by watering railway-stocks, then it instantly follows that they have not been accumulated by the management and operation of railways; and thus another of Mr. Hudson's charges falls to the ground. And the facts are within this statement. As a matter of fact these accumulators of mammoth fortunes were operators in Wall Street, who by accident became loaded with a favorite security, or with the debentures or stock of a single corporation, which necessitated (or at least suggested) their identification or assumption of the management, directorship, or presidency of this, that, or the other railway corporation. In not a single case have these fortunes arisen from the earning power of the road itself. If a certain railway corporation increases its stock without proportionately increasing its earning power, then the transaction is properly characterized as "stock-watering." But it does not make all railways enemies of the republic, nor in any way cause them to "dominate" the people who have granted them franchises for transportation purposes. It is from a prevalence of the very spirit which Mr. Hudson's volume, "The Railways and the Republic," labors vigorously and constantly to cultivate in this people, that railway-wrecking and stock-watering ever become possible. If Mr. Hudson honestly desires to make stock-watering impossible, let him advise his constituency to yield the railways such tariffs as they are obliged to demand, thus enabling them to meet their fixed charges and so keep out of the hands of "speculative directors," who will, from private greed, proceed to "water" their stocks. Here is a field wherein Mr. Hudson could write books to his heart's content, from a consistent, public spirited, and even contemporary standpoint, and with the best results. The mere collecting of antique newspaper-clippings is, beyond the passing amusement of the hour, of very small utility, of trifling exemplary value, and certainly of not the slightest assistance whatever in solving the problem of the American railway.

III. Eminent Domain.—Mr. Hudson's definition of this facility of railroad companies is as follows: "To take away the property of A and give it to B for the latter's private use and behoof, provided always that B is a railway corporation" (page 114). Now, actually and practically, the above is a remarkably comprehensive and exact definition, not of eminent domain but of what eminent domain is not, and of what it never can be under any circumstances. Mr. Hudson himself has inadvertently told us what it really is: "Experience shows that no railroad twenty-five miles in length can be built without the resort to the power of the State, for there are always some proprietors who demand an exorbitant price, or altogether refuse to let the railway

pass over their property. . . . No railroad of greater importance than a mere switch ever has been or ever can be built without invoking the sovereignty of the Government in its behalf" (page 111). Under such circumstances, where a man's neighbors have decided that they want a railway, the law—so far from taking anything from anybody—simply steps in and applies the well-known maxims that a man must use his own so as not to injure his neighbors; and that, in civilized communities, every citizen yields a fraction of his rights for the general good and society of all. To enable the railway to enforce the general consent, it is convenient to apply these maxims against the recalcitrant citizen by the fiction that the Government endows the railroad company—for the emergency and for the emergency only—with a portion of its own (the Government's) right to take the property of its subjects in cases of necessity (as for the public good in times of peace, or the public defense in time of war, etc.). This force is applied, however, not at the expense of the Government, nor even at the expense of the recalcitrant and unpleasant citizen who will not accord with his neighbors, but at the sole expense of the railway company. The result is that, instead of the citizen suffering for his obduracy and obstinacy, he is actually rewarded—since he ultimately receives a greater value for his land, without being mulcted in any of the expenses of the taking. So far as he is concerned he has lost nothing by his contumacy; whereas the railway, by his contumacy and without fault on its part, has been put to the costliest plan of acquiring the land. For the purchase of any strip of land, at almost any price, is invariably cheaper than the process of condemnation by private "view," which, both in time and money, is by all odds the very costliest known method of obtaining a railroad's right of way. These "views" are, by statutory requirement, made by persons of the vicinage, who, in estimating their neighbor's land, estimate their own; as individuals it can be readily imagined they are not over-solicitous to save the corporation expense, nor to estimate at all without liberal compensation to themselves for their own services: and the result can be readily computed. The laws of eminent domain, as appertaining to railway companies, and their operation in cases of land condemnation, are too technical to be elaborated here. But it may be said, as a matter of fact, that their application ceases with the single act of the acquirement of land. Nor is the power of the Government over the citizen ever, except in this solitary instance, exercised by the railway company from the beginning to the fine and term of its career; and, moreover, the grant itself is not only not against public policy and interest, but is directly in favor of the public: being positively granted to the railways as against themselves rather than in their favor, so far as a possible question between the railways and the public can possibly arise.

What is known as the police power of railways, which is derived

from and determined by the local police power of each separate community, although sometimes granted by proclamation from the State Executive, since Mr. Hudson has not assailed it, I will not defend. In the granting of railway passes I confess my inability to discover a crime against the State. Wherein they differ from the orders that a manager issues to seats in a theatre—especially since his theatrical privileges come from the people by special license—I am unable to perceive. "Passes" are the small currency of the railway company, payable for favors not estimated in, or convertible to, money; and are used just as the small trader bestows an apple or a toy upon the juvenile carrier between his small customer and himself. The company's rule is to issue passes only for services; but the rule is construed liberally to apply to prospective as well as actual services, and to count presumed influence, or perhaps an assumed or expected favorable mention of the particular corporation issuing them as a service. But, even if issued for no service, real or prospective, I know of no human being, institution, or concern, public or private, that is not allowed to perform acts complimentary in their nature, or even entirely gratuitous. In the course of many years' experience I have seen fully as many acts of public charity as of private compliment performed by railway companies. A friendless and penniless woman, whose husband has been left behind or has deserted her, *en route* she knows not whither, can be transported to a desired destination, if not in the discretion of the conductor, at least by telegraphing for permission to the proper department. And there is not a railway in the country where such gratuitous services are not constant, and as unchronicled and unheralded as they are constant. While I frankly say that, for one, I can not see where the granting either of charities or of "passes" militates against the public character imposed by Legislatures upon railroads, or is forbidden by the fact that to facilitate its construction the railway company once enjoyed a parcel of the State's power of eminent domain; I must admit that (except as to employés) the system has always been a nuisance to the railway companies which they have constantly labored to abolish. It is impossible to forecast what quantum of credit Mr. Hudson and his kind may take unto themselves for the Interstate Commerce Act, which has at last promised the railways a grateful relief from the pass-beggar. But if that act shall abolish both pools and passes, public sympathy will be with the honest shipper who must pay increased tariffs, rather than with the local Solon who wakes to find that—while screaming at "discriminations" and "long and short hauls"—he has actually been emptying his own pockets of the passes with which they were lined.

The power of the Government over the citizen, then, except in this solitary instance of land condemnation, being never exercised by a corporation: being bestowed invariably and always for the benefit and in the interest of the people, and not of the railway company; taking

always the shape of a duty and never the shape of a privilege—granted that railroads are *quasi*-public corporations, it would appear to follow—since they are only *quasi*-public, that they have still some elements of a private nature; and (since it is their private and not their public character which continues) that it is by this private character they must be continually judged. Granted that they must carry freights for the public in such a way as not to injure either the public or the freight in the carrying, most emphatically (it seems to me) it does not follow that they must add to the value of the freights they carry by charging only such rates as the public, or the owners of the freight, insist on. Mr. Hudson, as a member of society, has a presumptive right to light and air; to life, liberty, and the pursuit of happiness. Supposing that society should pass one law affirmatively compelling Mr. Hudson to recognize his neighbor's rights to life, liberty, and the pursuit of happiness; and, on top of that, another restraining him from interfering with these rights; still another compelling him to positively contribute in cash or services to the life, liberty, and the pursuit of happiness of his neighbors; and add to all these a still further law taking away his (Mr. Hudson's) own life, liberty, etc., because he had not in the past so contributed? Would not Mr. Hudson begin after a while to consider the propriety of looking up his own constitutional privileges; or, possibly, the charter of the particular society that was enacting all these statutes?—or query, perhaps, if the mere grant of power to breathe himself were a fair consideration for the burden of seeing to it that the entire neighborhood breathed? But our laws are daily imposing upon the railway companies they have chartered (on account of this so-called *quasi*-public character which the once granting of this long-lapsed power of eminent domain has saddled upon them) the duty of carrying whatever of passengers or freight is offered—of reasonably accommodating the public—of forfeiture of their charter if, even at a loss, trains are not so run as to accommodate reasonably; of operating, whether at a profit or at a deficit (under penalties for refusal to perform services desired of them)—under a burden of proof always to prove a negative if the refusal is alleged of them—under a disadvantage always before a jury—and of being obliged to accept the jury always of the locality where ideas of value and damage are the largest. Liabilities always to patrons, servants, abutters and adjoiners; to the State; compelled to pay damages for accidents caused by trespasses on their own rights of way; to maintain alert and vigilant counsel always to watch, lest at any moment they inadvertently overlook any of the thousands of statutes that thirty-eight Legislatures are annually pouring from the legislative mill; black-mailed on every hand, and always under the conviction that the average citizen sees no dishonesty in getting the better of them by dodging fares, or getting passes under false pretenses; and, if they receive a public gift of land, having it at once construed against them and carried to

defend it against the grantor himself in the grantor's own courts—these are the least of the burdens which this once granted and quickly terminated privilege of eminent domain is supposed to impose, and practically does impose, upon railway companies. Admitting their public character—even such a character is, perhaps, not morally a deterrent to the rights of their stockholders to get the interest on their investment; or otherwise a displacement of the unwritten law of *meum* and *tuum*. Railroads, by the uniform decisions of half a century, are indeed public conveniences. But, so far, this character of a public convenience has been only a burden, never a blessing, or even a shield. The man who steals a ride on a railway-train and imputes it to himself for sin would be a curiosity. The railway company has no conscience-fund; and, had it, there would be no contributors. It may submit to robbery, may carry for less than the cost of the service, and so plunder its stockholders to its heart's content, and Mr. Hudson and his clique have no protest to put on record. But if under all this load the railway company succumbs to bankruptcy, Mr. Hudson, from his elastic standpoint (or rather from his lack of any standpoint whatever) is enabled to cite this very bankruptcy as another instance of the hostility and danger of railways to the republic. He has charged them with being enemies to the public, firstly, because of their tariffs. He charges them, secondly, with being public enemies because of the bankruptcy which a failure to collect those tariffs has brought upon them; and yet again, thirdly—when that bankruptcy has made the stock nominal in value and so speculative, and a shrewd operator absorbs it and so lays the foundation of a private fortune—Mr. Hudson still charges the railways with being public enemies because the far-seeing operator has accumulated this very private fortune! Moreover, he lumps the whole *catena* of cause and effect into a series of indictments (or, more absurdly still, into a series of specifications under a single indictment against railways as a class or an institution), and proposes as a relief from the whole—what? Why, that the Government confiscate (or purchase by way of condemnation) these railways, and make them a public highway upon which any one may run his own rolling-stock on payment of a trackage-fee!

I know what the railways of this continent are, what services they perform. I know that, by vigilant watch for and adoption of the latest triumphs of engineering and mechanical skill, and by employment of the costliest of expert assistance, they have reduced the percentage of accident to a minimum, and the chances of loss of life to a fraction so small that it is actually a mathematical truth to assert that a man is safer in a railway-train running at full speed than in his bed, or in any other spot on this most precarious globe! What these railways could become if operated upon Mr. Hudson's plan I can not question; the details of that picture I can not, for one, fill in. I know not what terminal facilities, what time-tables, or what percentage of slaughter

would be necessary did every man, woman, and child possess the inalienable right to place upon their tracks their own locomotives, their own passenger-coaches and freight-carriages, and to run them at their own sweet will hither and thither. Nor can my fancy devise where all this rolling-stock would be stored when not in use (unless, indeed, means were devised to suspend it, by balloons or other aërial contrivance, over the railways themselves). Mr. Hudson does not discuss these questions at all, but leaves them, possibly, to the inventive genius of the race. And there, perhaps, we may also rest them.

But, taking leave of Mr. Hudson and his chimera, we have yet before us the railways themselves. Against the inequality of their own rates and the hardship of the long and short haul (in other words, against the discriminations of Nature and of physical laws), no less than against the peril of bankruptcy and the consequent speculative tendency of their stocks (after which may come the wrecking, the watering, and the vast individual fortunes), the railways of this republic have endeavored, by establishment of pool commissions, to defend both the public and themselves; and, whatever their motive may have been, their record as to that can not be disturbed. As to the effect of the Interstate Commerce Law upon the shipper and the passenger, time and trial alone can testify. But it is precisely such literature as Mr. Hudson's, and the sentiment it manufactures, which have made railway-wrecking, stock-watering, and their concomitant disasters possible; while for these disasters, down to date at least, the pool has been found the only and entirely adequate remedy. That remedy, drastic as it is, the railways (far from being public enemies) have themselves applied. The honest administration of railways for all interests, the payment of their fixed charges, the solvency of their securities, the faithful and valuable performance of their duties as carriers, can be conserved in but one way—by living tariffs such as the pools have guaranteed. But we want no living tariffs, says our Mr. Hudson. Give us a governmental control, and we will pay no tariffs—only a trackage-fee! Supposing this revolution accomplished, and how many years or months would, perhaps, elapse before another declamation in five hundred more pages of close type against the excessive trackage-fees, the favors to public officials or private cronies, or a formulated demand that the Government provide terminals at its own expense (another planet, possibly), sumptuous rolling-stock, motive power, and accident insurance policies for its passengers would arrive from the constant, sleepless, and irrepressible Mr. Hudson? Is it not, after all, Mr. Hudson and his kind—and not the Wall Street operator who trades on the sham public opinion they manufacture—who are the true stock-waterers, railroad-wreckers, and enemies of this republic?

SOME HUMAN INSTINCTS.

By WILLIAM JAMES,
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IT is generally considered that a cardinal *differentia* of the human race is its poor endowment in the way of instincts. Brutes need instincts, it is supposed, because they have no reason. But man, with his reason, can do without instincts. "Instinctive actions," says Professor Preyer, in his careful little work, "Die Seele des Kindes," "are in man few in number, and, apart from those connected with the sexual passion, difficult to recognize after early youth is past. So much the more attention," he adds, "should science pay to the instinctive actions of young children."

I believe this doctrine to be a great mistake. Instead of having fewer, man has more instincts than any other mammal. He has so many that they bar one another's path, and produce an indeterminateness of action in him, supposed to be incompatible with that automatic uniformity which, according to popular belief, characterizes all instinctive performances. Popular belief is here in error. The more carefully instincts have been studied of late years, and the more clearly their mechanism has been laid bare, the more evident has it become that their effects are liable to be modified by various conditions. Instincts are due, at bottom, to the organization in the nerve-centers of certain paths of discharge, or reflex-arcs, as they are technically called. The disturbance produced in the way of sound, light, or other sensible emanation, by some object in the environment, runs in at an animal's senses, and then out through his muscles. Each special sort of disturbance or stimulus affects a special set of muscles, and makes the animal act in a special way, he knows not why, except that it seems the only natural way to act at the moment. Witness the fear of a natural enemy, the love of the opposite sex, the pursuit of a natural prey. Some of these reflex-arcs are transient. Some of the environing objects stimulate more than one arc at once (as when the presence of a strange dog awakens timorous, pugnacious, and sociable movements, all at the same time, in another dog), and then small accidents determine the resultant path of discharge. Finally, habits are formed of reacting on one particular object of a kind, and inhibit the application of the instinct to other individuals (limitation of the sexual instinct to one mate, etc.). In an article published elsewhere,* I have tried to trace these complications and variations, and to show that the presence of too many instincts in a creature, some of them transient, some of them tending in opposite ways, some of them inhibited in their application by the habits earliest formed, must needs produce a

* "Scribner's Magazine," March, 1887.

life, as unautomatic and ununiform in its outward aspect, as human life has ever been claimed to be.

In this article and a later one, I will run over the human instincts in detail, commenting with fullness only upon such as are interesting enough to repay the pains.

The line to be drawn between simply reflex and instinctive actions is an entirely arbitrary one; so I can see no objection, on the score of principle, to including under the title of instincts Professor Preyer's whole list of the gradually evolving propensities to action of the human babe: *Sucking, biting, spitting, making grimaces, clasping, pointing, making sounds expressive of desire, carrying objects to the mouth, averting head and body, sitting up, standing,* are all accomplishments which come in due order, and lead us to the locomotor age. Each is irresistibly called forth by some appropriate stimulus, and finally becomes subject to the conscious will.

Locomotion is more interesting. Until the walking impulse ripens in the nerve-centers, the legs remain limp and indifferent, no matter how often the child may be hung with his feet in contact with the ground. No sooner, however, has the standing instinct come, than the child stiffens his legs and presses downward as soon as his feet feel the floor. In some babies this is the earliest locomotor reaction. In others it is preceded by the impulse to *creep.* Yesterday, the baby sat contentedly wherever he was put. To-day, it is impossible to keep him sitting at all, so irresistible is his impulse to throw himself forward on his hands. Usually the arms are too weak, and the ambitious little experimenter falls on his nose. But his perseverance is dauntless, and he soon learns to travel in the quadrupedal way. The *walking* instinct may awaken with no less suddenness, and its entire education be completed within a week's compass, barring a little "grogginess" in the gait. The common belief that a baby *learns* to walk is, strictly speaking, untrue. The reflex machinery, as it begins to ripen, prompts him to its use. But, as it is imperfectly organized, he makes mistakes. If, however, a baby could be prevented from getting on his feet at all for a fortnight or so after his first impulse to do so had manifested itself, and then restored to freedom, I have little doubt of his then being able to walk perfectly, or almost perfectly, "from the word 'go.'" A small blister on each foot-sole would do the business; and it is much to be desired that some scientific widower, left alone with his infant at the critical moment, should repeat on the human species the brilliant observation of Mr. Douglas Spalding on various small birds, which he kept till they were fully fledged, and then found to fly with absolute perfection the first time he allowed them to spread their wings. Usually, birds start to fly before either the central or peripheral apparatus is quite ripe. And so do we, to walk.

Of *vocalization* I will say nothing except that it is instinctive in both of its forms, singing and speech, and that the propensity to speak

often ripens in a child with almost startling suddenness. A few significant sounds are gradually acquired, but the vocabulary is very small until the impulse of imitating sounds awakes. When its awakening is abrupt it is impossible to talk with the child. His condition is that of *echolalia:* instead of answering, he repeats the question. His whole energy may for a few days be poured into this channel, and during those days the foundations of his future vocabulary are laid.

Imitation is a human instinct which has other fields of application than the vocal one. Say what one will of monkeys, man is the imitative animal. Civilization, in fact, depends on the trait. *Nil humani a me alienum,* is the motto of each of us, and we are uneasy when another shows any power or superiority, till we can exhibit it ourselves as well. Much might be said of this propensity, as well as of the impulse to *rivalry* which is akin to it, and equally instinctive; but I must hasten on to—

Sympathy is an emotion as to whose instinctiveness psychologists have held hot debate, some of them contending that it is no primitive endowment, but, originally at least, the result of a rapid calculation of the good consequences to ourselves of the sympathetic act. Such a calculation, at first conscious, would grow more unconscious as it became more habitual, and at last, tradition and association aiding, might prompt to actions which could not be distinguished from immediate impulses. It is hardly needful to argue against the falsity of this view. Some forms of sympathy, that of mother with child, for example, are surely primitive, and not intelligent forecasts of support to be reaped in old age. Danger to the child blindly and instantaneously stimulates the mother to actions of alarm or defense. Menace or harm to the adult, beloved, and friend, excites us in a corresponding way, often against all the dictates of prudence. It is true that sympathy does not necessarily follow from gregariousness. Sheep and cattle do not help a wounded comrade; on the contrary, they are more likely to dispatch him. But a dog will lick another sick dog, and even bring him food; and the sympathy of monkeys is proved by many observations to be strong. In man, then, we may lay it down that the sight of suffering or danger to others is a direct exciter of interest, and an immediate stimulus, if no complication hinders, to acts of relief. There is nothing unaccountable or pathological about this—nothing to justify Professor Bain's assimilation of it to the "fixed ideas" of insanity, as "clashing with the regular outgoings of the will." It may be as primitive as any other "outgoing," and may be due to a random variation selected, quite as probably as, in Spencer's opinion, gregariousness and maternal love are due to such variations.

It is true that sympathy is peculiarly liable to inhibition from other instincts which its stimulus may call forth. The traveler whom the good Samaritan rescued may well have prompted such instinctive fear

or disgust in the priest and Levite who passed him by, that their sympathy could not come to the front. Then, of course, habits, reasoned reflections, and calculations may either check or re-enforce; as may also the instincts of love or hate, if these exist, for the suffering individual. The hunting and pugnacious instincts, when aroused, also inhibit our sympathy absolutely. This accounts for the cruelty of collections of men hounding each other on to bait or torture a victim. The blood mounts to the eyes, and sympathy's chance is gone.

Pugnacity and anger. In many respects man is the most ruthlessly ferocious of beasts. As with all gregarious animals, "two souls," as Faust says, "dwell within his breast," the one of sociability and helpfulness, the other of jealousy and antagonism to his mates. Though in a general way he can not live without them, yet, as regards certain individuals, it often falls out that he can not live with them either. Constrained to be a member of a tribe, he still has a right to decide, as far as in him lies, of which other members the tribe shall consist. Killing off a few obnoxious ones may often better the chances of those that remain. And killing off a neighboring tribe from whom no good thing comes, but only competition, may materially better the lot of the whole tribe. Hence the gory cradle, the *bellum omnium contra omnes*, in which our race was reared; hence the fickleness of human ties, the ease with which the foe of yesterday becomes the ally of to-day, the friend of to-day the enemy of to-morrow; hence the fact that we, the lineal representatives of the successful enactors of one scene of slaughter after another, must, whatever more pacific virtues we may also possess, still carry about with us, ready at any moment to burst into flame, the smoldering and sinister traits of character by means of which they lived through so many massacres, harming others, but themselves unharmed.

The hunting instinct has an equally remote origin in the evolution of the race. The hunting and the fighting instinct combine in many manifestations. They both support the emotion of anger; they combine in the fascination which stories of atrocity have for most minds; and the utterly blind excitement of giving the rein to our fury when our blood is up (an excitement whose intensity is greater than that of any other human passion save one), is only explicable as an impulse aboriginal in character, and having more to do with immediate and overwhelming tendencies to muscular discharge than to any possible reminiscences of effects of experience, or association of ideas. I say this here, because the pleasure of disinterested cruelty has been thought a paradox, and writers have sought to show that it is no primitive attribute of our nature, but either a semblance or a resultant of the subtile combination of other less malignant elements of mind. This is a hopeless task. If evolution and the survival of the fittest be true at all, the destruction of prey and of human rivals *must* have been among the most important of man's primitive functions, the fighting

and the chasing instincts *must* have become ingrained. Certain perceptions *must* immediately, and without the intervention of inferences and ideas, have prompted emotions and motor discharges; and both of the latter must, from the nature of the case, have been very violent, and therefore, when unchecked, of an intensely pleasurable kind. It is just because human bloodthirstiness is such a primitive part of us that it is so hard to eradicate, especially where a fight or a hunt is promised as part of the fun.*

As Rochefoucauld says, there is something in the misfortunes of our very friends that does not altogether displease us; and an apostle of peace will feel a certain vicious thrill run through him, and enjoy a vicarious brutality, as he turns to the column in his newspaper at the top of which "shocking atrocity" stands printed in large capitals. See how the crowd flocks round a street-brawl! Consider the enormous annual sale of revolvers to persons, not one in a thousand of whom has any serious intention of using them, but of whom each one has his carnivorous self-consciousness agreeably tickled by the notion, as he clutches the handle of his weapon, that he will be rather a dangerous customer to meet. See the ignoble crew that escorts every great pugilist—parasites who feel as if the glory of his brutality rubbed off upon them, and whose darling hope, from day to day, is to arrange some set-to of which they may share the rapture without enduring the pains! The first blows at a prize-fight are apt to make a refined spectator sick; but his blood is soon up in favor of one party, and it will then seem as if the other fellow could not be banged and pounded and mangled enough—the refined spectator would like to re-

* It is not surprising, in view of the facts of animal history and evolution, that the very special object blood should have become the stimulus for a very special interest and excitement. That the sight of it should make people faint is strange. Less so that a child who sees his blood flow should forthwith become much more frightened than by the mere feeling of the cut. Horned cattle often, though not always, become furiously excited at the smell of blood. In some abnormal human beings the sight or thought of it exerts a baleful fascination. "B and his father were at a neighbor's one evening, and, while paring apples, the old man accidentally cut his hand so severely as to cause the blood to flow profusely. B was observed to become restless, nervous, pale, and to have undergone a peculiar change in demeanor. Taking advantage of the distraction produced by the accident, B escaped from the house and proceeded to a neighboring farm-yard, where he cut the throat of a horse, killing it." Dr. D. H. Tuke, commenting on this man's case ("Journal of Mental Science," October, 1885), speaks of the influence of blood upon him—his whole life had been one chain of cowardly atrocities—and continues: "There can be no doubt that with some individuals it constitutes a fascination. . . . We might speak of a *mania sanguinis*. Dr. Savage admitted a man from France into Bethlehem Hospital some time ago, one of whose earliest symptoms of insanity was the thirst for blood, which he endeavored to satisfy by going to an abattoir in Paris. The man whose case I have brought forward had the same passion for gloating over blood, but had no attack of acute mania. The sight of blood was distinctly a delight to him, and at any time blood aroused in him the worst elements of his nature. Instances will easily be recalled in which murderers, undoubtedly insane, have described the intense pleasure they experienced in the warm blood of children."

enforce the blows himself. Over the sinister orgies of blood of certain depraved and insane persons let a curtain be drawn, as well as over the ferocity with which otherwise fairly decent men may be animated, when (at the sacking of a town, for instance), the excitement of victory long delayed, the sudden freedom of rapine and of lust, the contagion of a crowd, and the impulse to imitate and outdo, all combine to swell the blind drunkenness of the killing-instinct, and carry it to its extreme. No! those who try to account for this from above downward, as if it resulted from the consequences of the victory being rapidly inferred, and from the agreeable sentiments associated with them in the imagination, have missed the root of the matter. Our ferocity is blind, and can only be explained from *below*. Could we trace it back through our line of descent, we should see it taking more and more the form of a fatal reflex response, and at the same time becoming more and more the pure and direct emotion that it is.

In childhood it takes this form. The boys who pull out grasshoppers' legs and butterflies' wings, and disembowel every frog they catch, have no *thought* at all about the matter. The creatures tempt their hands to a fascinating occupation, to which they have to yield. It is with them as with the "boy-fiend" Jesse Pomeroy, who cut a little girl's throat, "just to see how she'd act." The normal provocatives of the impulse are all living beasts, great and small, toward which a contrary habit has not been formed—all human beings in whom we perceive a certain *intent* toward *us*, and a large number of human beings who offend us peremptorily, either by their look, or gait, or by some circumstance in their lives which we dislike. Inhibited by sympathy, and by reflection calling up impulses of an opposite kind, civilized men lose the habit of acting out their pugnacious instincts in a perfectly natural way, and a passing feeling of anger, with its comparatively faint bodily expressions, may be the limit of their physical combativeness. Such a feeling as this may, however, be aroused by a wide range of objects. Inanimate things, combinations of color and sound, bad bills of fare, may in persons who combine fastidious taste with an irascible temperament, produce real ebullitions of rage. Though the female sex is often said to have less pugnacity than the male, the difference seems connected more with the extent of the motor consequences of the impulse than with its frequency. Women take offense and get angry, if anything, more easily than men, but their anger is inhibited by fear, and other principles of their nature, from expressing itself in blows. The hunting-instinct proper seems to be decidedly weaker in them than in men. The latter instinct is easily restricted by habit to certain objects, which become legitimate "game," while other things are spared. If the hunting-instinct be not exercised at all, it may even entirely die out, and a man may enjoy letting a wild creature live, even though he might easily kill him. Such a type is now becoming frequent; but there is no

doubt that in the eyes of a child of Nature such a personage would seem a sort of moral monster.

Fear is a reaction aroused by the same objects that arouse ferocity. The antagonism of the two is an interesting study in instinctive dynamics. We both fear, and wish to kill, anything that may kill us; and the question which of the two impulses we shall follow, is usually decided by some one of those *collateral circumstances* of the particular case, to be moved by which is the mark of superior mental natures. Of course, this introduces uncertainty into the reaction; but it is an uncertainty found in the higher brutes as well as in men, and ought not to be taken as proof that we are less instinctive than they. Fear has bodily expressions of an extremely energetic kind, and stands, beside lust and anger, as one of the three most exciting emotions of which our nature is susceptible. The progress from brute to man is characterized by nothing so much as by the decrease in frequency of proper occasions for fear. In civilized life, in particular, it has at last become possible for large numbers of people to pass from the cradle to the grave without ever having had a pang of genuine fear. Many of us need an attack of mental disease to teach us the meaning of the word. Hence the possibility of so much blindly optimistic philosophy and religion. The atrocities of life become "like a tale of little meaning though the words are strong"; we doubt if anything like *us* ever really was within the tiger's jaws, and conclude that the horrors we hear of are but a sort of painted tapestry for the chambers in which we lie so comfortably at peace with ourselves and with the world.

Be this as it may, fear is a genuine instinct, and one of the earliest shown by the human child. *Noises* seem especially to call it forth. Most noises from the outer world, to a child bred in the house, have no exact significance. They are simply startling. To quote a good observer, M. Perez:

> Children between three and ten months are less often alarmed by visual than by auditory impressions. In cats, from the fifteenth day, the contrary is the case. A child, three and a half months old, in the midst of the turmoil of a conflagration, in presence of the devouring flames and ruined walls, showed neither astonishment nor fear, but smiled at the woman who was taking care of him, while his parents were busy. The noise, however, of the trumpet of the firemen, who were approaching, and that of the wheels of the engine, made him start and cry. At this age I have never yet seen an infant startled at a flash of lightning, even when intense; but I have seen many of them alarmed at the voice of the thunder. . . . Thus, fear comes rather by the ears than by the eyes, to the child without experience. It is natural that this should be reversed, or reduced, in animals organized to perceive danger afar. Accordingly, although I have never seen a child frightened at his first sight of fire, I have many a time seen young dogs, young cats, young chickens, and young birds frightened thereby. . . . I picked up some years ago a lost cat about a year old. Some months afterward at the onset of cold weather I lit the fire in the grate of my study,

which was her reception-room. She first looked at the flame in a very frightened way. I brought her near to it. She leaped away and ran to hide under the bed. Although the fire was lighted every day, it was not until the end of the winter that I could prevail upon her to stay upon a chair near it. The next winter, however, all apprehension had disappeared. . . . Let us, then, conclude that there are hereditary dispositions to fear, which are independent of experience, but which experiences may end by attenuating very considerably. In the human infant I believe them to be particularly connected with the ear.*

The effect of noise in heightening any terror we may feel in adult years is very marked. The *howling* of the storm, whether on sea or land, is a principal cause of our anxiety when exposed to it. The writer has been interested in noticing in his own person, while lying in bed, and kept awake by the wind outside, how invariably each loud gust of it arrested momentarily his heart. A dog, attacking us, is much more dreadful by reason of the noises he makes.

Strange men, and *strange animals*, either large or small, excite fear, but especially men or animals advancing toward us in a threatening way. This is entirely instinctive and antecedent to experience. Some children will cry with terror at their very first sight of a cat or dog, and it will often be impossible for weeks to make them touch it. Others will wish to fondle it almost immediately. Certain kinds of "vermin," especially spiders and snakes, seem to excite a fear unusually difficult to overcome. It is impossible to say how much of this difference is instinctive and how much the result of stories heard about these creatures. That the fear of "vermin" ripens gradually seemed to me to be proved in a child of my own to whom I gave a live frog once, at the age of six to eight months, and again when he was a year and a half old. The first time, he seized it promptly, and holding it, in spite of its struggling, at last got its head into his mouth. He then let it crawl up his breast, and get upon his face, without showing alarm. But the second time, although he had seen no frog and heard no story about a frog between whiles, it was almost impossible to induce him to touch it. Another child, a year old, eagerly took some very large spiders into his hand. At present he is afraid, but has been exposed meanwhile to the teachings of the nursery. Preyer tells of a young child screaming with fear on being carried near to the *sea*.

Solitude is a source of terror to infancy. The teleology of this is obvious, as is also that of the infant's expression of dismay—the never-failing cry—on waking up and finding himself alone.

* "Psychologie de l'Enfant," pp. 72–74, in an account of a young gorilla quoted from Falkenstein, by R. Hartmann ("Anthropoid Apes," "International Scientific Series," vol. lii, New York, 1886, page 265), it is said: "He very much disliked strange noises. Thunder, the rain falling on the skylight, and especially the long-drawn note of a pipe or trumpet, threw him into such agitation as to cause a sudden affection of the digestive organs, and it became expedient to keep him at a distance. When he was slightly indisposed, we made use of this kind of music with results as successful as if we had administered purgative medicine."

Black things, and especially *dark places*, holes, caverns, etc., arouse a peculiarly gruesome fear. This fear, as well as that of solitude, of being "lost," are explained after a fashion by ancestral experience. Says Schneider:

> It is a fact that men, especially in childhood, fear to go into a dark cavern or a gloomy wood. This feeling of fear arises, to be sure, partly from the fact that we easily suspect that dangerous beasts may lurk in these localities—a suspicion due to stories we have heard and read. But, on the other hand, it is quite sure that this fear at a certain perception is also directly inherited. Children who have been carefully guarded from all ghost-stories are nevertheless terrified and cry if led into a dark place, especially if sounds are made there. Even an adult can easily observe that an uncomfortable timidity steals over him in a lonely wood at night, although he may have the fixed conviction that not the slightest danger is near.
>
> This feeling of fear occurs in many men even in their own house after dark although it is much stronger in a dark cavern or forest. The fact of such instinctive fear is easily explicable when we consider that our savage ancestors through innumerable generations were accustomed to meet with dangerous beasts in caverns, especially bears, and were for the most part attacked by such beasts during the night and in the woods, and that thus an inseparable association between the perceptions of darkness of caverns and woods, and fear took place, and was inherited.*

High places cause fear of a peculiarly sickening sort, though here, again, individuals differ enormously. The utterly blind, instinctive character of the motor impulses here is shown by the fact that they are almost always entirely unreasonable, but that reason is powerless to suppress them. That this is a mere incidental peculiarity of the nervous system, like liability to sea-sickness, or love of music, with no teleological significance, seems more than probable. The impulse is so much of an individual idiosyncrasy, and its detrimental effects are so much more obvious than its uses, that it is hard to see how it could be a selected instinct. Man is anatomically one of the best fitted of animals for climbing about high places. The best psychical complement to this equipment would seem to be a "level head" when there, not a dread of going there at all. In fact, the teleology of fear, beyond a certain point, is very dubious. Professor Mosso, in his interesting monograph, "La Paura" (which has recently been translated into French), concludes that many of its manifestations must be considered pathological rather than useful; Bain, in several places, expresses the same opinion; and this, I think, is surely the view which any observer without *a priori* prejudices must take. A certain amount of timidity obviously adapts us to the world we live in, but the *fear-paroxysm* is surely altogether harmful to him who is its prey.

Fear of the supernatural is one variety of fear. It is difficult to assign any normal object for this fear, unless it were a genuine ghost.

* "Der Menschliche Wille," p. 224.

But, in spite of psychical research-societies, science has not yet adopted ghosts; so we can only say that certain *ideas* of supernatural agency, associated with real circumstances, produce a peculiar kind of horror. This horror is probably explicable as the result of a combination of simpler horrors. To bring the ghostly terror to its maximum, many usual elements of the dreadful must combine, such as loneliness, darkness, inexplicable sounds, especially of a dismal character, moving figures half discerned (or, if discerned, of dreadful aspect), and a vertiginous baffling of the expectation. This last element, which is *intellectual*, is very important. It produces a strange emotional "curdle" in our blood to see a process, with which we are familiar, deliberately taking an unwonted course. Any one's heart would stop beating if he perceived his chair sliding unassisted across the floor. The lower animals appear to be sensitive to the mysteriously exceptional as well as ourselves. My friend Professor W. K. Brooks, of the Johns Hopkins University, told me of his large and noble dog being frightened into a sort of epileptic fit by a bone being drawn across the floor by a thread which the dog did not see. Darwin and Romanes have given similar experiences.* The idea of the supernatural involves that the usual should be set at naught. In the witch and hobgoblin supernatural, other elements still of fear are brought in—caverns, slime and ooze, vermin, corpses, and the like.† A human corpse seems normally to produce an instinctive dread, which is no doubt somewhat due to its mysteriousness, and which familiarity rapidly dispels. But, in view of the fact that cadaveric, reptilian, and underground horrors play so specific and constant a part in many nightmares and forms of delirium, it seems not altogether unwise to ask whether these forms of dreadful circumstance may not at a former period have been more normal objects of the environment than now. The ordinary cock-sure evolutionist ought to have no difficulty in explaining these terrors, and the scenery that provokes them, as relapses into the consciousness of the cave-men, a consciousness usually overlaid in us by experiences of more recent date.

There are certain other pathological fears, and certain peculiarities

* "Cf. Romanes, "Mental Evolution," etc., p. 156.

† In the "Overland Monthly" for this year, a most interesting article on Laura Bridgman's writings has been published by Mr. E. C. Sandford. Among other reminiscences of her early childhood, while she still knew nothing of the sign-language, the wonderful blind deaf-mute records the following item: "My father [he was a farmer and probably did his own butchering] used to enter his kitchen bringing some killed animals in and deposited them on one of sides of the room many times. As I perceived it it make me shudder with terror because I did not know what the matter was. I hated to approach the dead. One morning I went to take a short walk with my Mother. I went into a snug house for some time. They took me into a room where there was a coffin. I put my hand in the coffin & felt something so queer. It frightened me unpleasantly. I found something dead wrapped in a silk h'd'k'f so carefully. It must have been a body that had had vitality. . . . I did not like to venture to examine the body for I was confounded."

in the expression of ordinary fear, which might receive an explanatory light from ancestral conditions, even infra-human ones. In ordinary fear, one may either run, or remain semi-paralyzed. The latter condition reminds us of the so-called death-shamming instinct shown by many animals. Dr. Lindsay, in his work on "Mind in Animals," says this must require great self-command in those that practice it. But it is really no feigning of death at all, and requires no self-command. It is simply a terror-paralysis which has been so useful as to become hereditary. The beast of prey does not think the motionless bird, insect, or crustacean dead. He simply fails to notice them at all; because his senses, like ours, are much more strongly excited by a moving object than by a still one. It is the same instinct which leads a boy playing "I spy" to hold his very breath when the seeker is near, and which makes the beast of prey himself in many cases motionlessly lie in wait for his victim or silently "stalk" it, by rapid approaches alternated with periods of immobility. It is the opposite of the instinct which makes us jump up and down and move our arms when we wish to attract the notice of some one passing far away, and makes the shipwrecked sailor frantically wave a cloth upon the raft where he is floating when a distant sail appears. Now, may not the statue-like, crouching immobility of some melancholiacs, insane with general anxiety and fear of everything, be in some way connected with this old instinct? They can give no *reason* for their fear to move; but immobility makes them feel safer and more comfortable. Is not this the mental state of the "feigning" animal?

Again, take the strange symptom which has been described of late years by the rather absurd name of *agoraphobia*. The patient is seized with palpitation and terror at the sight of any open place or broad street which he has to cross alone. He trembles, his knees bend, he may even faint at the idea. Where he has sufficient self-command he sometimes accomplishes the object by keeping safe under the lee of a vehicle going across, or joining himself to a knot of other people. But usually he slinks round the sides of the square, hugging the houses as closely as he can. This emotion has no utility in a civilized man, but when we notice the chronic agoraphobia of our domestic cats, and see the tenacious way in which many wild animals, especially rodents, cling to cover, and only venture on a dash across the open as a desperate measure—even then making for every stone or bunch of weeds which may give a momentary shelter—when we see this we are strongly tempted to ask whether such an odd kind of fear in us be not due to the accidental resurrection, through disease, of a sort of instinct which may in some of our ancestors have had a permanent and on the whole a useful part to play?

In a subsequent paper I shall try to consider man's remaining instincts in a similar way.

THEOLOGY UNDER ITS CHANGED CONDITIONS.

By Rev. CANON FREMANTLE.

A PROFESSOR of divinity who has been thought at times to be by no means insensible to a reputation for orthodoxy, preaching in the University of Oxford a few days ago, said: "The field of speculative theology may be regarded as almost exhausted; we must be content henceforward to be Christian agnostics." It is probable that these words, had they been uttered in the same place twenty-five years ago, would have excited an alarm comparable to that which was raised by Bishop Colenso or the "Essays and Reviews." In the present case they appear to have been accepted without a murmur; so great is the change which has come over the conditions of theological thought in England in a quarter of a century. It will be the object of the present paper to make clear what are the new conditions of which theology has to take note, to point out what they involve either certainly or by probable inference, and to show what we may expect theology to be under these new conditions.

It is very necessary that such an attempt should be made, so that illusions should cease, and also unnecessary alarms; and that theologians should strike boldly into the new paths, not reverting to unfruitful methods which separate theology from other parts of human knowledge. For it is to be observed that such utterances as that just quoted are met with again and again, even when least expected, in theological literature, but that this has by no means prevented the prevalence of dogmatism. St. Augustine wrote, in his treatise on "Christian Doctrine":

> God is unspeakable; yet what we say of him would not be spoken at all if it were unspeakable. Even when we say God is unspeakable, we hardly speak rightly; for even in saying this we make an assertion. By pronouncing the word *Deus*, we do not make him known as he is. Only when that sound strikes the ears of men who know Latin, it moves in them the thought of a certain most excellent and immortal nature.

Yet this did not hinder him from repeating the language in which he had suddenly checked himself, and his methods have so enchained the study of theology that we are only now beginning to free ourselves from them. The melancholy experience of the sixteenth century which turned the Reformation from a great act of emancipation into a renewed scholasticism must not be repeated in our day.

The conditions which it is necessary to notice may be taken under four heads: 1. Those imposed by the advance of science, and 2. Of criticism; 3. Those made by the altered state of church-life; 4. Those caused by social and democratic progress.

1. Under the head of Science we may notice as specially bearing

on theology the fuller knowledge of the laws of nature with the increasing sense of their uniformity which imposes itself as a necessary condition of thought wherever things physical are concerned; the hypothesis of evolution, which suggests an account in harmony with this uniformity of the genesis of the whole animate creation; and, turning to another department, the history of religion, of which so much more is know now than formerly. 2. In referring to criticism we may dwell upon the discoveries recently made as to the dates of the books of the Old Testament, and the consequent rearrangement of Hebrew literature and history; the views now given by scholars of the origin of the Gospels, the diminished historical value which it is found necessary to ascribe to the Acts of the Apostles, the dubious character of the later Epistles ascribed to St. Paul, and the greater clearness of the circumstances under which the Apocalypse was composed—we must pass on to the investigations into the structure of the early Christian Churches and their theological ideas, especially those relating to the Eucharist, and we must also take in the change which has come about in the treatment of all early documents—that which teaches us to value them as literature, not as the quarry from which dogmatic statements may be hewed out. 3. Turning to the conditions of church-life we shall have to notice the abolition or mitigation of tests and subscriptions, and the greater tolerance and friendliness between those who hold different opinions or belong to different religious bodies; the freedom which the law of the Church, as interpreted by the Privy Council, gives to theological opinions of clergymen; together with the tendency, to which all religious bodies have been subject for some time past, to make less of abstract theological statements and more of practical piety and philanthropy. 4. Lastly, turning to the social and political conditions, we must consider the effect of our greater acquaintance with the wants of the masses, and the admission of the demand for equality. Theology has to take account not of a mere mass of ignorance and sin, but of human beings standing in moral equality with their teachers, and capable of virtue and self-direction, who require to be told, not, after the manner which reminds them of the older political economy, of a way of salvation under which a few elect souls may be saved, but, in a manner corresponding with the better social policy, how they may be helped to rise in all respects and all together.

Before going more into detail and showing the necessary or probable effects of these conditions upon theology, there are three remarks which should be made:

First, in the present day every institution is passing through the ordeal of criticism, and lives only because it can justify its existence. It would be foolish, if it were possible, to attempt the exemption of the study of theology from this process. Nor is there any reason why it should shrink from the questioning, if only it be applied with the

patience and care which are necessary in dealing with an abstract subject, and one which touches men's inmost susceptibilities. This patience is required alike from those who are irritated by the old usurpations of theology, and would not be sorry if it could be banished altogether, and from those who esteem theology as the venerable mother and head of the sciences, and fear lest her majesty should be disparaged by too unabashed a gaze.

Secondly, it is neither honest nor politic to hide the real state of things. The questions which it suggests are felt not only by theologians, but by many thoughtful ministers and laymen; and we need not doubt that they are honestly met and solved in many cases. But the impression on the mind of the laity is that a hard system of dogmas which they have identified with "the gospel" exists unmodified in the mind of the clergy, and that theologians are quite unaware of the change which modern conditions have imposed upon religious thought. For instance, Professor Huxley, some years ago, when asked to give an address to the London clergy, proved in an elaborate exposition that the world was more than six thousand years old. Probably there was hardly one of his hearers, even at that time, who needed to be convinced of it. But theologians must feel that it is not mere personal and esoteric conviction, but a frank acknowledgment of the conditions of things, which is needed for the vindication of the dignity of their science and of their own intelligence and veracity.

Thirdly, it is not to be supposed, as sometimes happens, that those who subject an institution to such an ordeal are detracting from it. Criticism is not necessarily negative. More than thirty years ago Prince Albert said that constitutional government was on its trial, at a time when it hardly existed in any great European country but England. The trial it underwent was so successful that it is now recognized, more or less, as the form of government in all Europe, except Russia and Turkey. Criticism, moreover, even where barely negative, is often the means of purging away the dross and making the metal appear in its purity. Theology at the Christian era and at the Reformation underwent such a purification, and stood forth afterward far stronger and more fit for the purposes of piety. We must get down, at whatever expense, to the solid rock, and then we can safely build; but the tower we build will be nobler and more useful, because it stands firm. We need have no fear as to the future of theology and of the religious life which is founded upon it.

I.—1. To begin with the conditions imposed by the physical sciences. The immense advance which has been made in this department, alike in the way of discovery, of diffusion, and of application, is the most marked intellectual feature of our epoch. But physical science can not advance a step without the assumption of the uniformity of Nature. This uniformity is tested at every stage and never fails. The idea that it can fail becomes almost inconceivable. When the

student turns to experience, he finds that violations of natural order which were supposed to take place in old times now take place no more; that no such violations can be found in times and places where they can be verified. Even in the sphere of Christian apologetics this is admitted more and more. The position of miracles has completely changed. They are no longer the basis of the argument, but are themselves the subject of apology. One accepted writer puts them in the fifth rank of evidences. Bishop Temple, in his "Bampton Lectures," shows by his treatment of them that they have lost their power. It is only the fact that they are supposed to be bound up with the moral and spiritual forces of Christianity which prevents their being treated as wholly indifferent.

We notice next the theory of evolution. Let it be granted that it is still a theory, and that the vast gaps in the geological record, and the chasm between man and brute, are not filled up. Yet the existence of evolution, in a constantly increasing circle of observed phenomena, is clear; and it would be perilous to rest any belief upon a supposition that the theory, even in its full compass, will be disproved. It is said that life must have had a beginning. Is it certain that life itself has not been developed, as some persons believe, or that the potency of life is not inherent in the elements of which the world is formed? The evidence may not at present point toward such a conclusion; but again it would be perilous to build upon the opposite theory. Indeed, the idea of creation must be admitted to be a negative rather than a positive idea. God made the world; but how? As soon as we attempt to put a positive sense into the word creation, it fails us. But what, it is asked, and where, is God, if he be not a creator? We must conceive of him otherwise than as a workman standing outside his work.

If we turn from the physical sciences to the science of language, which is said by Professor Max Müller to be itself a physical science, we are led up through comparative philology to comparative theology. The knowledge of the religions of the East and West shows us in their development points of the closest analogy with that recorded in the Bible, and the question is forced upon us whether there is any line to be drawn between them. Is not the idea of God in some of them both monotheistic and moral? If we fix our minds upon ideas once thought to be exclusively Christian, are there not incarnations and miraculous births and resurrections in the Brahmanical religion? Is there not the idea of self-sacrifice and of the equality of men in Buddhism? Does not Confucius come very near, to say the least, to the enunciation of the golden rule of the gospel? And has not this estimate of the Eastern religion so forced itself upon us that, whereas before the knowledge of the sacred books of the East missionaries were apt to speak only of the perishing heathen, and of their superstition and immorality, which were sinking them to perdition, now they speak rather of the hopeful side of their life, and apply the gospel as the means of evoking

this into perfection? We evidently must not assert for Christianity an exclusive place in the upraising of the world to God.

2. Passing on to the sphere of criticism, we find that the Old Testament has undergone a great change. The successive labors of Ewald, Graf, and Wellhausen, in Germany; of Kuenen, in Holland; of Reuss among French, and Robertson Smith among English critics, have won the general assent of scholars—even of men of such conservative leanings as Delitzsch, in Germany; of Briggs, in America; and of the Oxford Hebraists, Driver and Cheyne. The "Guardian" newspaper, which represents the more educated opinion of the Anglican clergy, published, on the 3d of last November, a cautious article, from which we may infer its readiness to accept the results of this criticism, and its consciousness that Christian doctrine has nothing to fear from it. Let us endeavor to give a succinct account of these results.

The Pentateuch is now held to be of Mosaic origin only in the sense of incorporating historical and legal elements, which a tradition, partly but not wholly trustworthy, had handed down as connected with Moses. In its present state it consists mainly of three elements: 1. The early documents, which combine two sources, one of which uses the name Jehovah, the other Elohim; 2. The Deuteronomic; and, 3. The priestly: these three elements are represented in successive casts of the law by, 1. The Decalogue and the book of laws in Exodus xx–xxiii; 2. The Book of Deuteronomy; 3. The Book of Leviticus; and took shape in writings, the first about 800 B. C.; the second at the time of Manasseh or Josiah; the third during the period between Ezekiel and Ezra. In these three periods the early documents were successively rehandled, so that the first four books bear traces of the later influence, first of the Deuteronomist, and, secondly, of the Levitical writers; the Book of Joshua, also, has been subjected to the same processes, being, in fact, a continuation of the first five books, and forming with them the "Hexateuch." The histories, from Judges to 2 Kings, form a connected work, the various parts of which were composed at various times, some of them being contemporary with the events described, but which took its final shape in the time of Jeremiah. The Books of Chronicles, Ezra, and Nehemiah, form similarly one work, written under priestly influence long after the time of Ezra. The Book of Esther is a very late work, its claims to be placed in the Canon being disputed by the rabbis down to the Christian era. The Psalms are of many ages and authors, the Psalms actually written by David being limited to a very few, possibly to the eighteenth alone. The Proverbs belong to Solomon only in the sense in which the Psalms belong to David. Job is of quite uncertain date and origin, while Ecclesiastes belongs to the later Persian era, and the Song of Songs to the days of the northern kingdom. The Prophets remain as the solid center, their date beginning with the eighth century B. C., and the books being written by those whose names they bear, with the exception of Isaiah xl–xlvi,

which belongs to the Babylonish captivity; of parts of Zechariah, which belong to several periods; and of the Book of Daniel, which is not properly to be numbered with the Prophets (the critics in this respect following the old Jewish estimate), but consists of a series of traditions put together for the encouragement of the faithful Jews in the time of the Maccabees.

In regard to the New Testament there is far less tendency to agreement among scholars. The researches relating to the Synoptic Gospels have made it clear that they are not independent accounts, but have a common origin either in an oral or a written tradition which was variously handled; that in all probability Mark was the oldest and Luke the latest of the three, but that the title "according to" St. Matthew or St. Mark permits of the hypothesis that they passed through a rehandling in a later generation of their disciples, and that the same is highly probable in the case of the fourth Gospel, which, however, many believe to have been wholly composed in the second century by some disciple or successor of St. John; that the Acts of the Apostles can not be wholly relied on for the details of the history; that the four great epistles of St. Paul are the earliest and most certain Christian documents; and that no reasonable doubt attaches to the Epistles to the Thessalonians. The Epistles of the Captivity present so different an aspect of Christianity that their actual Pauline authorship is the subject of some doubt, though from this doubt the Epistle to the Philippians is almost free; the pastoral Epistles, however, can not be treated with any certainty as having been written by St. Paul himself, and the Hebrews are almost certainly by another, though one in close sympathy with him. The Epistle of St. James is reckoned genuine; the Second Epistle of St. Peter and that of Jude are liable to the gravest doubts, and the First Epistle of Peter is not wholly undoubted. The Johannine epistles go with the fourth Gospel, and can hardly be by the same author as the Apocalypse, which is fixed almost without doubt to be the work of the apostle, and to have been written in the reign of the Emperor Galba.

It is, of course, quite possible that some of these opinions may be unsound. Few of them are wholly undisputed. It is possible also that the estimate here given of the tendency of opinion may not be entirely correct. Yet it can hardly be far from the truth; and the main lines of this criticism acquire a greater certainty and acceptance every year. In any case it has become impossible to deal with the sacred history as exempt from the conditions of ordinary history, or with the Psalms and prophets as if their glowing words could be taken as definitions of theological truths or rules of life. In the history we have to pick our way amid many doubtful paths, to ask at every turn whether the facts are exactly as they have been represented. Even in the didactic portions we have to inquire whether the sayings are genuine, and if so, to which of the various phases of a rapidly-chang-

ing development they belong. We have to admit the various tendencies in the teaching of the apostles; and, in regard to the central figure of all, to gain from books subject to the same incidents as other forms of literature, and written by men who imperfectly understood him, our consciousness of the value of his life, his character, his teaching, and of his relation to mankind and to God.

The early history of the Church has likewise been subjected to a minute criticism, which has been stimulated of late by the discovery of the "Teaching of the Twelve Apostles." The result has been to give us a simpler view of the organization of the Christian societies and of their life and thoughts, to show the influence of various social circumstances working naturally upon them, and forming their institutions and their theology. It becomes less and less possible to attribute to the earliest period of the Church, as having been formally imposed or exclusively admitted, any of the theories of Church government which we now know, whether Episcopal, Presbyterian, or Independent, or the formed doctrines of later times, whether relating to the plan of redemption or to the Incarnation or the Trinity.

3. While the progress of science and criticism have thus made new conditions for theological thought, church-life has also undergone changes which allow of the necessary expansion. First, we must recall the formal liberation of opinion effected mainly by the judgment of the Privy Council, delivered in 1864, in the cases arising out of the "Essays and Reviews." The alarm excited ten years before by Mr. Maurice's theological essays, especially on the questions of the atonement and of eternal punishment, and by the works of Professor Jowett and Dr. Rowland Williams, found expression in Mr. Mansel's "Bampton Lectures"; and when there appeared successively the first volume of Bishop Colenso's work on the Pentateuch, which was practically a polemic against verbal inspiration, and the "Essays and Reviews," which were a distinct demand for liberty of thought in the authorized teachers of the English Church, this alarm showed itself in the shape of prosecutions for heresy. Out of the multitude of statements impugned in the "Essays" of Dr. Williams and Mr. Wilson three only remained on which the Privy Council were called to adjudicate; but they represented the three departments of theology on which liberty was most distinctly demanded: 1. The Atonement and Justification; 2. The Inspiration of Scripture; 3. Eternal Punishment. The charge relating to the first of these was withdrawn, and on the other two the judgment was in favor of the accused. Thus an almost complete liberty was won on the matters then under discussion, and the principles on which the judgment was based practically gave a similar assurance on other points. The tendency of the Privy Council, as representing the supremacy of the national over ecclesiastical law, has been almost uniformly in favor of liberty. It has been possible in a few extreme cases to procure the condemnation of cler-

gymen for matters of opinion; but these cases have been very rare, and the tendency to give liberty has been even-handed. The Gorham case gave a similar liberty to those who denied abnormal or supernatural power to one of the sacraments; the Bennett case gave liberty to those who asserted a similar power in the other. Even in cases of ritual, which stand on a different ground, being matters of formal regulation, there has been great unwillingness to press hardly on conscientious men, even when palpably defying the law; and the bishops have vindicated for themselves a power of stopping suits which they consider vexatious.

This action of the Privy Council corresponds with the general feeling. The different sections of the clergy and their adherents who made some outcry against the judgments, have gradually adopted more and more of the spirit of toleration which characterizes the law. To a large extent the judgments in doctrinal matters have preluded an actual change of opinion. The stringent doctrine of substitution as the essence of the atonement, the notion of inspiration as consisting in verbal accuracy rather than in the general spirit of the book, the belief in the everlasting perpetuation of sin and suffering, are alike strange to the present generation. They may still be held in some form, but probably in all cases with modifications, and they are certainly not insisted on as marks of true religion.

It may be partly the ill-success of past prosecutions for heresy, or it may be a consciousness that we are none of us in such literal conformity with the standards as to warrant us in casting stones at one another, or it may be some other consideration, which is the cause of the present aversion from an appeal to the courts. At all events, such an aversion exists. A striking proof of it has lately been furnished at Oxford. The rector of the City Church, Mr. Carteret Fletcher, was "delated" to the vice-chancellor for a sermon preached before the university, which contained the following passages:

1. Not long ago it was the general belief that man had been created perfect, but that he had fallen from perfection into an abyss of doom, whence only an elect fragment of the race would emerge; but it is now dawning on us that man was created in an undeveloped state, with a splendid potential wealth of faculty, and that he has advanced through long ages to his present stage, whence he is destined to rise higher than imagination can follow him. In him we see a rough-hewed block in course of being molded into perfect shape, and not the reconstruction of the shattered pieces of a faultless image.

2. The historical evidence of Christ's resurrection, after traversing a gulf of eighteen centuries, loses much of its convincing force in a scientific age which takes its stand on the uniformity of law. But this failing of the external evidence is more than compensated by our deeper realization of the inward proofs of human immortality; by our faith in the eternity of Christ's character, as well as by our consciousness of the high capacities and affections which he has called forth in us, and which are "mocked by the brevity of life, and are totally incapable of exhaustion here."

On these passages the accusation was grounded—1. That the preacher departed, and that knowingly, from the teaching of St. Paul on the fall of Adam. 2. That he denied the fact of the resurrection of our Lord. 3. That he claimed for the teachers of to-day to correct the teaching of the apostles, and of the Church on various other points.

It is true that three of the six doctors whom the vice-chancellor considered himself bound by the statute to appoint to inquire into the complaint could not bring themselves to pronounce Mr. Fletcher's teaching as free from the charge of being "dissonant or contrary to the doctrine of the Church of England as publicly received"; and that he was acquitted only by the casting vote of the vice-chancellor. But not only was the feeling of both residents and non-residents, of all shades of opinion, strongly adverse to the proceeding, but (we quote from the journal which represents the more conservative and clericalist side of university opinion) "an opinion to this effect was conveyed to Mr. Ffoulkes (the delator) in a letter signed by a number of those whose judgment might be supposed likely to have weight with him"; and it is added, "Mr. Ffoulkes's action is entirely his own." We may add that a certain sense of incongruity is imparted to the proceeding by the fact that Mr. Ffoulkes was himself for some time the holder of views within the Church of England which led him to become for some years a Roman Catholic. But the prevalent feeling has been that expressed by Trajan about persecution, "Non nostri sæculi est." As Mr. Fletcher says in the preface to his published sermon: "It is so incongruous with the ideas of our time that, even in serious people, it excites a sense of humor. It is like fighting with bows and arrows after the invention of cannon. Let us hope it will have the historical interest of being the last instance of its kind; the last flickering, expiring flame of a fire which once burned so fiercely, and nowhere more so than in Oxford." This feeling is shared by religious persons generally. It may rightly be said that almost any opinion, if put forward with sincere conviction and in a becoming spirit, will be allowed an unprejudiced hearing; and that, whether in the university or in the Church generally, prosecutions for matters of opinion are very unlikely to be repeated.

This conviction arises from the fact that this aversion from prosecution is not an isolated fact. It is connected with a spirit of tolerance which is wide-spread and well-grounded. Meetings like the Church Congress and the Diocesan Conferences have made the clergy and their adherents know and esteem one another, and Church parties have not the bitter antagonism they once had. In clerical circles this tolerance as yet hardly extends to Nonconformists; the clergy still to a great extent hold theories, and still more entertain exclusive feelings, which separate them and those attached to their teaching from co-operation in all spiritual things with dissenters. But there

are exceptions to this which are becoming more frequent; personal esteem is often sincerely felt even where co-operation is refused, and co-operation is sometimes given in philanthropic schemes when refused in spiritual work. The free discussion of religion in the reviews and magazines and in private circles induces a still larger tolerance, so that even agnostics and positivists are not treated as outcasts by the most zealous of their Christian relations.

We must add to this the new state of things created by the modification of the tests imposed upon the clergy, and their abolition both in public life and at the universities. The clergy now profess only a general adherence to the formularies of worship, while in all other spheres tests are gone or doomed. This has tended to make religious profession more sincere, and to separate religion from injustice. It has also brought together those who would never have met. The presence even of one like Mr. Bradlaugh in Parliament is a preservative against conventionalism and hypocrisy when matters moral and religious are under debate. In the universities the fact that young men who are preparing for the ministry of various denominations, live together and share the same thoughts and associations, is pregnant with consequences to the future of church-life and of theology, as is also the freedom of speech and practice and the altered tone of religious instruction resulting from the presence of dissenters.

4. Theology can not separate itself from public life. The democratic and social uprising of our day must influence it. While a system of privilege was dominant in the state, it was natural perhaps to think of the few who were called, and to pass over the rest. The idea of men having no claim upon God, and of his relation to them as being either that of a vigorous upholder of law, or of one who only in certain cases and on certain terms showed favor to transgressors, was congenial to all to whom the chief political factors were the monarch and the upper classes, and the maintenance of a law in the making of which the mass of the subjects had had no hand. But the modern conviction that all men have their rights, and that the government exists for their sake, has communicated itself to theology. We can not think of men simply as offenders who need pardon; rather the fact that they have been created seems to give them a claim on their Creator. The mission and self-sacrifice of Christ seem an answer to this claim, and a promise of a better condition in this world as well as in the world to come. Nor is this only for individuals. The democracy moves in masses; we can not be content with the blessing of individuals as separate from their fellows, but must strive for the building up of the masses in true relations and brotherly equality.

Such appear to be the main conditions under which our theological beliefs are destined in future to move. We have now to consider what the movements of theology can be under these conditions.

II.—When the preacher whose words were quoted at the beginning

of this article said that we must be Christian agnostics, he used the term agnostic not in the sense in which it is frequently used, and which implies, first, that it is more than doubtful whether the objects of theology exist at all; and, secondly, that it is a pestilent piece of folly to seek for any knowledge about them; but simply in the sense that they must be approached by other paths than those of a speculation which results in the formation of dogmas. The distinguished inventor of the name agnostic has in a recent number of this Review reminded us that "physical science is as little atheistic as it is materialistic." It may be as well to quote the passage ("Fortnightly Review" for December, 1886, page 799):

> The student of Nature who starts from the axiom of the universality of the law of causation, can not refuse to admit an eternal existence; if he admits the conservation of energy, he can not deny the possibility of an eternal energy; if he admits the existence of immaterial phenomena in the form of consciousness, he must admit the possibility at any rate of an eternal series of such phenomena; and, if his studies have not been barren of the best fruit of the investigation of Nature, he will have enough sense to see that, when Spinoza says, "Per Deum intelligo ens absolute infinitum, hoc est substantiam constantem infinitis attributis," the God so conceived is one that only a very great fool indeed would deny, even in his heart. Physical science is as little atheistic as it is materialistic.

Mr. Herbert Spencer goes further, and dwells upon this eternal energy as the mystery of mysteries, and considers that religion as maintaining the sense of this mystery is one of the most important factors of human life. We are all alike in the admission of a great object of thought to which the name of God has commonly been given. We have all to co-operate in the endeavor to estimate the nature and character of that object.

In the sermon above quoted it was pointed out that literature was one of the channels through which the great objects of theology would in future be approached. The preacher implied, like Mr. Matthew Arnold, that the literary conceptions of God and immortality ("words thrown out at a great subject," to use Mr. Arnold's expression) bring us nearer to the truth than dogmatic statements. It is not very different from what Aristotle says about morals "We must be content in such matters to exhibit the truth roughly and in a figure, and to reach our object by words which describe it in the general and to draw inferences of the same kind; for it is the mark of a man of culture to seek for exactness in each subject only so far as the nature of the thing admits. You do not expect exhortations from a mathematician or demonstration from a rhetorician." But theologians have commonly started in entire defiance of this warning. They have begun with axioms and definitions, and have proceeded to demonstrations. They have said or "proved" that God is just or good, God is personal, God is omniscient and omnipotent; and they have used these phrases not

in a literary but a *quasi*-scientific manner, and have then proceeded to draw strict inferences from them. But in doing this they have not only acted in the way of unwarrantable assumption: they have often produced what St. Paul termed the vain janglings of a science falsely so called, have enslaved the Divine to their own puny conceptions, and have provoked violent revolt.

Suppose that a similar process had been applied to the greatest of moral powers, that of love. Suppose that men had upheld the importance of love by saying love is supreme, spontaneous, disinterested, and had written treatises to "prove" these statements, and had made deductions from them with little aid from experience; suppose that others had contradicted some of these statements and deductions, saying that love depends upon circumstances, upon juxtaposition, or upon prudential considerations, and that we have power over it, that it is a duty. Then suppose that each side had invoked poetry, proverbs, or historical records to "prove" his own theory, and had insisted that every verse or line that was quoted involved a certain proposition or dogma about love, and that, unless such a proposition was admitted, neither thought nor feeling nor action in the subject had any meaning or validity, so that the only question was which theory was correct. Suppose, further, that a physicist came in among them and said: "All this is quite unreal; love is a function of the bodily organization, and depends upon age and health, upon the state of the nerves, the heart, and the liver"; should we think that any of these processes was reasonable, or that any of them exalted our estimate of love? Should we not sweep them all away, and welcome one bright saying, one little idyl, one embrace, as having more meaning and bringing us more to the root of the matter than all of them?

In religious matters abstract reasoning is not our best mode of reaching truth. The objects we are dealing with are too great and too distant. We approach them from various sides, and say what we can and what appears true; but it is often by metaphor, and parable, and poetry, and by the experience which gives us the actual dealings of God with men rather than by direct statements, that we can perceive and convey to others any theological truth. This does not imply that we abandon a constructive theology, but that we must so speak as not to narrow down the true sense of the divine which we wish to receive and impart, that we must take account of all the conditions, that we must constantly appeal to experience; and, lastly, that the systems which we form must be understood to be a response to the intellectual need of our own day, necessarily imperfect, and always liable to revision.

1. As regards God. Instead of asserting *a priori*, or taking ready-made from the Scriptures abstract statements, such as those alluded to above, theologians must accept as their task the attempt to give a true account of the totality of things which is also a unity impelled by a

single power or energy. They will show the traces of order, mind, and purpose which the world presents, and will cautiously draw from the processes of human life as that which is highest in the moral scale their inferences as to the nature of the Supreme Power. They will not merely be careful not to contravene the laws of Nature, but will consider essential a knowledge of them as manifestations of the Supreme Will, to which men must reverently submit themselves. They will not spend time in questions which admit of no solution, such as the eternity of matter or the origin of the world, or the possibilities of other spheres of life than those known to us by experience. They will trace the divine as working through Nature and man; or, if they endeavor to think of a transcendental God, they will take care not to represent him as a demiurge standing outside his work and putting in his hand here and there, a conception which has turned so many physicists into atheists. But they will feel able to speak of God as just and loving, since the Supreme Power *ex hypothesi* includes mankind, the leading portion of the world, with all its noblest ideals. They need not quarrel with those who think of the Supreme Power rather after the analogy of force or law than according to the strict idea of personality, provided that the moral nature of man be held fast and its supremacy acknowledged.

2. As regards the Scriptures. The theologian of our new epoch will start without any theory of inspiration. He will be ready to admit that God has revealed himself in part in other systems, ancient and modern. He will not pretend that the Scriptures are absolutely perfect in any part, but will take them for what they are really worth, and as constituting a history and a literature in which the development of religion is to be studied. But the fact that the Bible can not be used as the infallible mine of ready-made statements concerning history and morals, will throw him back from the letter to the spirit, from the external proof to the truth which is gained by thought and prayer; while the development of religion described in Scripture, which even now stands forth in clear outline, will be found to be unique in its variety and completeness, and at the same time a type of the development of religion generally. The beauty and harmony of the whole, and the moral elevation of special parts, will gain by this natural treatment, as well as by comparison with other sacred books; and the study will become more attractive, more inspiring, and more capable of giving strength and consolation.

3. As to the nature of Christ. Putting aside the long controversies which began in the third century, the theologian will be content to exhibit him as he really was, and then to trace and estimate the power which his life and spirit have exerted over mankind. The fact that he takes human nature as the chief guide to the divine, and does not pretend to an absolute knowledge of God, will give a new and peculiar interest to the study of the life and influence of Christ. It

will make men much more cautious in framing dogmas about his divinity; but experience in the future as in the past can but increase the sense of his moral supremacy, and the power of his life and death. And it is supremacy, not exclusiveness, which must be vindicated for the whole Christian system. These two terms, supremacy and exclusiveness, may be taken as marking the contrast between the position of Christianity under the new and under the old conditions.

4. As to miracles. It is evident that the arguments relied on in the last century do not help us now. We see that they imported the idea of a violation of the order of Nature into a time when no such notion as the order of Nature existed; that they assumed an exactness of observation and description in the narrators which our knowledge of the times and the documents forbids us to assume; and further that they dwelt on the mere physical process, while to the writers it is a part of the "many good works shown them from the Father," or the "signs of the kingdom of heaven." The theologian of the future will probably be little concerned with them. We have all learned to read in a natural sense the account of the crossing of the Red Sea, which even Mr. M. Arnold, some years ago, took as meant to record a violation of physical order. The strong east wind; the cloud which beat in the faces of the Egyptians, but by its lightning showed the Israelites their way; the waters kept back at low tide by the east wind, and walling in the course of the fugitives, but returning upon their pursuers when the tide rose and the eye of God looked forth upon them through the cloud in the morning, lose nothing in majesty or in providential importance when we read them without importing violations of the laws of Nature. And so it will be in many other cases; while as to those which are notable only for their strangeness, the action of hyperbole and the growth of the wonderful by tradition will be always present to the mind of the theologian, and will make him pass over them "with a light foot." We have no difficulty when we read of the miracles of St. Bernard or the prophecies of Savonarola, nor do they interfere with our estimate of those great men. The miracles of healing in the Gospel will, we can hardly doubt, always appear as evidence of a peculiar condition of human life in the East in the first century, and of the restorative power of a great personality. Little stress will be laid on the accounts of the infancy of Christ, since they are mentioned nowhere in the New Testament, outside the first chapters of the first and third Gospels. The case of the resurrection is quite different, since it passed immediately into the Christian consciousness. But the theologian who starts from the Epistles of St. Paul as the solid central ground of New Testament literature, will go upon the apostle's teaching that not flesh and blood, but the spiritual personality—clothed in the new house which is from heaven—inherits the kingdom of God, and will take the vision by which the apostle was converted as the type of all the manifestations by which the companions of Christ were

assured that he was not lost but gone before. He will, with St. Paul, take the assurance that Christ was alive after his passion as the fulfillment of the general hope of immortality which Israel had long entertained.

This hope of immortality was grounded on the connection of man with God, and espacially with his moral nature; and consequently, after the confirmation it received by the assurance of Christ's resurrection, it became a kind of passionate certitude. The history of the Church, however, shows how such a passion may become a great danger and source of corruption; and we may expect that the theologians of the future will substitute the "words thrown out at a great subject" for the certitude and definitions of the past. Immortality will be to them a great background of hope beyond the scene of present duty.

5. The theology of sin and redemption. This is the department of theology in which a kind of ideal dogmatism has most interfered with truth. The ideal characters of the wicked and the just, as they are described in Scripture, have been taken as literally existing; and, since men can not be ranked with the ideally righteous, they have been taken in the mass as belonging to the ideally wicked. Each action has been regarded as a conscious and open-eyed contradiction of a revealed standard of right, a contradiction which is described in the Gospel as a sin against the Holy Ghost. The false judgments, the mutual condemnations, the hypocrisy, the strange theories of redemption, the readiness to believe in eternal torments, the ascetic practices and unreal life which have resulted from this, could hardly be traced out in a lifetime. The reconstruction which will be required will need great labor. But in no department will the results be more fruitful. They will bring theological ethics into closer alliance with general science and practice. They will enable Christian teachers to treat all men as brothers, and make Christianity the means by which the state of men generally may be ameliorated.

6. The notion of the Church, the study of Church history, and the practice of church-life will be profoundly modified when once men realize that the Church is not necessarily a society held apart from the rest of mankind by having different pursuits as its object, and a peculiar form of government enjoined upon it. The Church will be simply that section of mankind in which the Christian spirit reigns; its history will be the history of the working out of the Divine principle in human society, with all its blessed results. The Church of the future will make its worship bear upon the higher ends of life; or, rather, it will teach that the true ritual is a holy life in all its departments, and thus it will merge itself more and more in general society, being ready, in the true spirit of its Lord, to lose itself that it may save mankind.

If we ask, in conclusion, what the prospects are as to the actual

coming in of this better theology, there are three things which may enable us to answer hopefully.

First, the tolerance, which has been mentioned as one of the conditions under which we live, makes the path smooth before us. That which some have dignified by the name of "The New Reformation" has, we may hope, passed its stage of contention. The facts and views which have been set forth in this paper are not opposed by any solid array of party opinion, but rather find men in all parties who admit them. The ground, therefore, has been cleared, and the building has to be erected. The chief point on which our energies must be expended is Church history. This study, in its larger sense, embraces almost the whole field. The study of Scripture itself is mainly the study of the historical development by which the Church was prepared and founded. The study of dogma can not be profitable unless its history be known, and its various phases taken in combination with the circumstances of the time. And the knowledge of the progress made in the past is the surest guide for the future. History, therefore, is the frame in which all theological study must be set; and the knowledge of facts, their co-ordination and their significance, is that to which all theological students must turn their attention. We need not give up the hope of a full Christian philosophy, nor delay taking the initial steps toward it. But at every turn we are dependent on a knowledge of the path, which is as yet but imperfectly explored.

It may be asked, secondly, whether the introduction of these views will demand any great alteration in the formularies and practices of the Church. It is, indeed, desirable to give liberty, since tender consciences are fettered by any sense of bondage; and irritation, or needless pain, or incapacity, or in some cases hypocrisy, are the result. The clergy should not be required to make any subscription at all, but should simply be subject to the law of the system under which they serve. In the Church services some greater facilities for substitution and omissions would be desirable under the sanction of a competent local authority; and a document like the Athanasian Creed, which, where intelligible, recalls the age of controversies and condemnations, should not be read in the public services. But the chief adaptations of the old to the new must be made by thoughtful men for themselves; and the key to them will be found by going below the letter and seizing upon the real meaning of the assertions made, and translating them into practice. If the divinity of Christ is identified with his moral supremacy as a spiritual power; if the atonement means to us self-sacrifice, and faith a confidence in the divine righteousness; if absolution is the authoritative assurance of God's forgiveness; if election is the endowment of a few to be the leaders of the rest in Christian devotion, we shall not find any great difficulty in the language of the prayers and the other formularies in any of the Christian denominations.

Lastly, it is quite possible that much which is a puzzle to one generation will not be so to the next. It was often asked twenty years ago what would become of faith when men no longer believed the Bible to be infallible, and what of morality when they ceased to believe in eternal torments. But those who are now growing to maturity seem to find no lack of grounds for belief or of sanctions for practice. And the next generation may find no difficulty in the conditions of theological thought described in the first half of this article. The claims of Christian piety are strong, and the simplest doctrines are its best support. Duty, philanthropy, love, social and political improvement earnestly prosecuted in the fear of God and in the spirit of Christ, are independent of the ideas of dogmatic theology, and often unconscious of its changes.—*Fortnightly Review.*

ASTRONOMY WITH AN OPERA-GLASS.

THE STARS OF SUMMER.

By GARRETT P. SERVISS.

A SINGULAR proof of popular ignorance of the starry heavens, as well as of popular curiosity concerning any uncommon celestial phenomenon, is furnished by the curious notions prevailing about the planet Venus. When Venus began to attract general attention in the western sky in the early evening some two months ago, speculation quickly became rife about it, particularly on the great Brooklyn Bridge. As the planet hung dazzlingly bright over the New Jersey horizon, some people appeared to think it was the light of Liberty's torch, mistaking the bronze goddess's real flambeau for a part of the electric-light system of the metropolis. Finally (to judge from the letters written to the newspapers, and the questions asked of individuals supposed to know something about the secrets of the sky), the conviction seems to have become pretty widely distributed that the strange light in the west was no less than an electrically illuminated balloon, nightly sent skyward by Mr. Edison, for no other conceivable reason than a wizardly desire to mystify his fellow-men. I have positive information that this ridiculous notion has been actually entertained by more than one person of intelligence. And it is not improbable, that as Venus glows with increasing splendor in the serene evenings of June, she will continue to be mistaken for some petty artificial light instead of the magnificent world that she is, sparkling out there in the sunshine like a globe of burnished silver. Yet Venus as an evening star is not so rare a phenomenon that people of intelligence should be surprised at it. Once in every 584 days she reappears in the sunset sky—

> "Gem of the crimson-colored even,
> Companion of retiring day."

No eye can fail to note her, and as the nearest and most beautiful of the Earth's sisters it would seem that everybody should be as familiar with her appearance as with the face of a friend. But the popular ignorance of Venus, and the other members of the planetary family to which our mother, the Earth, belongs, is only an index of the denser ignorance concerning the stars—the brothers of our great father, the Sun. I believe this ignorance is largely due to mere indifference, which, in its turn, arises from a false and pedantic method of presenting astronomy as a jumble of mathematical formulæ, and a humble handmaiden of the art of navigation. Some teachers of astronomy are so fearful that their imagination may run away with them in the boundless fields of the universe, that they hobble it with a chain of ephemerides, break its jaw with a logarithmic bit, and end by earning what they, perhaps unconsciously, seek, a niche in the temple of Dry-as-dust. Of course, the public looks upon such things with indifference. Understand, I do not mean to cast doubt upon the scientific value of technical work in astronomy. The science could not exist without it. And no reproach is intended to those who have made the spectroscope reveal the composition of the sun and stars, and who are now making photography picture the heavens as they are, and even reveal phenomena which lie beyond the range of human vision. These are the men who have taken astronomy out of its swaddling-clothes, and set it on its feet as a progressive science. But when one sees the depressing and repellent effect that has evidently been produced upon the popular mind by the ordinary methods of presenting astronomy, one can not resist the temptation to utter a vigorous protest, and to declare that this glorious science is not the grinning mathematical skeleton that it has been represented to be.

Whoever will use an opera-glass, or even his naked eyes, with intelligence, in surveying the heavens, will quickly convince himself that all of astronomy is not embraced in the "Nautical Almanac."

In the April number of "The Popular Science Monthly" I pointed out some of the most interesting objects to be seen among the stars that adorn the sky in spring. The annual revolution of the heavens has now carried those stars that in April shone in the western sky below the horizon, while the constellations that were then in the east have now climbed to the zenith, or passed over to the west, and a fresh set of stars has taken their place in the east. In the present article we shall deal with what may be called the stars of summer; and, in order to furnish occupation for the observer with an opera-glass throughout the summer months, I have endeavored to so choose the constellations in which our explorations will be made, that some of them shall be favorably situated in each of the months of June, July, and August. The circular map represents the heavens at midnight on the 1st of June; at eleven o'clock, on the 15th of June; at ten o'clock, on the 1st of July; at nine o'clock, on the 15th of July; and at eight o'clock,

on the 1st of August. Remembering that the center of the map is the point over his head, and that the edge of it represents the circle of the horizon, the reader, by a little attention and comparison with the sky, will be able to fix in his mind the relative situation of the

various constellations. The maps that follow will show him these constellations on a larger scale, and give him the names of their chief stars.

The observer need not wait until midnight on the 1st of June in order to find some of the constellations included in our map. Earlier in the evening, at about that date, say at nine o'clock, he will be able to see many of these constellations, but he must look for them farther toward the east than they are represented in the map. The bright stars in Boötes and Virgo, for instance, instead of being over in the southwest, as in the map, will be near the meridian; while Lyra, instead of shining high overhead, will be found climbing up out of the

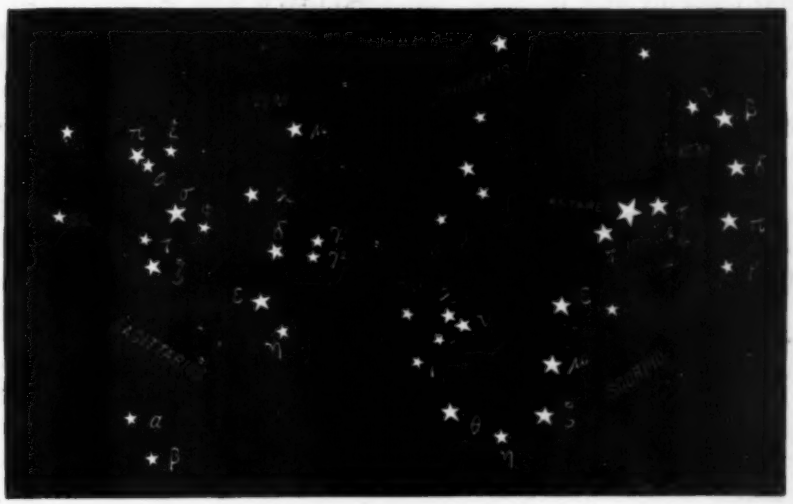
northeast. It would be well to begin at nine o'clock, about the 1st of June, and watch the motion of the heavens for two or three hours. At the commencement of the observations you will find the stars in Boötes, Virgo, and Lyra in the positions I have just mentioned, while half-way down the western sky will be seen the Sickle of Leo (see "Popular Science Monthly" for April). The brilliant Procyon and Capella will be found almost ready to set in the west and northwest, respectively. Between Procyon and Capella, and higher above the horizon, shine the twin stars in Gemini, with the planets Venus and Saturn, near each other, below them. There will be no difficulty in recognizing Venus, for it is now brighter than any other star in the heavens. Saturn would be regarded also as a very bright star, but for the overpowering contrast with its more brilliant sister. Looking over into the south, the observer will see the planet Jupiter a little east of Spica in Virgo, and second only to Venus in brilliancy.

In an hour Saturn and Venus will be setting, and Jupiter will be well past the meridian. In another hour the observer will perceive that the constellations are approaching the places given to them in our map, and at midnight he will find them all in their assigned positions. A single evening spent in observations of this sort will teach him more about the places of the stars than he could learn from a dozen books.

Taking, now, the largest opera-glass you can get (I have before said that the diameter of the object-glasses should not be less than 1·5 inch, and, I may add, the larger they are the better), find the constellation Scorpio, and its chief star Antares. The map shows you where to look for it at midnight on the 1st of June. If you prefer to begin at nine o'clock at that date, then, instead of looking directly in the south for Scorpio, you must expect to see it just rising in the southeast. You will recognize Antares by its fiery color, as well as by the striking arrangement of its surrounding stars. There are few constellations which bear so close a resemblance to the objects they are named after as Scorpio. It does not require a very violent exercise of the imagination to see in this long, winding trail of stars a gigantic scorpion, with its head to the west, and flourishing its upraised sting that glitters with a pair of twin stars, as if ready to strike. Readers of the old story of Phaeton's disastrous attempt to drive the chariot of the Sun for a day will remember it was the sight of this threatening monster that so terrified the ambitious youth that he lost control of Apollo's horses, and came near burning the earth up by running the Sun into it.

Antares rather gains in redness when viewed with a glass. Its color is very remarkable, and it is a curious circumstance that with powerful telescopes a small, bright-green star is seen apparently almost touching it. Antares belongs to Secchi's third type of suns, that in which the spectroscopic appearances suggest the existence of a

powerful absorptive atmosphere, and which are believed on various grounds to be, as Lockyer has said, "in the last visible stage of cooling"; in other words, almost extinct. This great, red star probably in actual size exceeds our sun, and no one can help feeling the sublime nature of those studies which give us reason to think that here we can



SCORPIO AND SAGITTARIUS.

actually behold almost the expiring throes of a giant brother of our giant Sun. Only, the lifetime of a sun is many millions of years, and its gradual extinction, even after it has reached a stage as advanced as that of Antares is supposed to be, may occupy a longer time than the whole duration of the human race.

The opera-glass will show a number of faint stars scattered around Antares. Turn now to Beta (β) in Scorpio, with the glass. A very pretty pair of stars will be seen hanging below β. Sweeping downward from this point to the horizon you will find many beautiful star-fields. The star marked Nu (ν) is a double which you will be able to separate with a powerful field-glass, the distance between its components being 40″.

And next let us look at a star-cluster. You will see on the map an object marked 4 M., near Antares. Its designation means that it is No. 4 in Messier's catalogue of nebulæ. It is not a true nebula, but a closely compacted cluster of stars. With the opera-glass, if you are looking in a clear and moonless night, you will see it as a curious nebulous speck. With a field-glass its real nature is more apparent, and it is seen to blaze brighter toward the center. It is, in fact, one of those universes within the universe where thousands of suns are associated together by some unknown law of aggregation into assemblages of whose splendor the slight view that we can get gives us but the faintest conception.

The object above and to the left of Antares, marked in the map 80 M., is a nebula, and although the nebula itself is too small to be seen with an opera-glass (a field-glass shows it as a mere wisp of light), yet there is a pretty array of small stars in its neighborhood worth looking at. Besides, this nebula is of special interest, because in 1860 a star suddenly took its place. At least, that is what seemed to have happened. What really did occur, probably, was that a variable or temporary star, situated between us and the nebula, and ordinarily too faint to be perceived, received a sudden and enormous accession of light, and blazed up so brightly as to blot out of sight the faint nebula behind it. If this star should make its appearance again, it could easily be seen with an opera-glass, and so it will not be useless for the reader to know where to look for it. The quarter of the heavens with which we are now dealing is famous for these celestial conflagrations, if so they may be called.

We shall presently see some examples of star-clusters and nebulæ with which the instruments we are using are better capable of dealing. In the mean time, let us follow the bending row of stars from Antares toward the south and east. When you reach the star Mu (μ), you are not unlikely to stop with an exclamation of admiration, for the glass will separate it into two stars that, shining side by side, seem trying to rival each other in brightness. But the next star below μ, marked Zeta (ζ), is even more beautiful. It also separates into two stars, one being reddish and the other bluish in color. The contrast in a clear night is very pleasing. But this is not all. Above the two stars you will notice a curious nebulous speck. Now, if you have a powerful field-glass, here is an opportunity to view one of the prettiest sights in the heavens. The field-glass not only makes the two stars appear brighter, and their colors more pronounced, but it shows a third, fainter star below them, making a small triangle, and brings other still fainter stars into sight, while the nebulous speck above turns into a charmingly beautiful little star-cluster, whose components are so close that their rays are inextricably mingled in a maze of light. This little cut is an attempt to represent the scene, but no engraving can reproduce the life and sparkle of it.

ZETA SCORPIONIS.

Following the bend of the Scorpion's tail upward, we come to the pair of stars in the sting. These, of course, are thrown wide apart by the opera-glass. Then let us sweep off to the eastward a little way and find the cluster known as 7 M. You will see it marked on the map. Above it, and near enough to be included in the same field of view, is 6 M., a smaller cluster. Both of these have a sparkling appearance with an opera-glass, and by close attention some of the separate stars in 7 M. may be detected. With a field-glass these clusters become much more strik-

ing and starry looking, and the curious radiated structure of 7 M. comes out.

In looking at such objects we can not too often recall to our minds the significance of what we see—that these glimmering specks are the lights in the windows of the universe which carry to us, across inconceivable tracts of space, the assurance that we and our little system are not alone in the heavens; that all around us, and even on the very confines of immensity, Nature is busy, as she is here, and the laws of light, heat, gravitation (and why not of life?) are in full activity.

The clusters we have just been looking at lie on the borders of Scorpio and Sagittarius. Let us cross over into the latter constellation, which commemorates the centaur Chiron. We are now in another, and even a richer, region of wonders. The Milky-Way, streaming down out of the northeast, pours, in a luminous flood through Sagittarius, inundating that whole region of the heavens with seeming deeps and shallows, and finally bursting the barriers of the horizon disappears, only to glow with redoubled splendor in the southern hemisphere. The stars Zeta (ζ), Tau (τ), Sigma (σ), Phi (ϕ), Lambda (λ), and Mu (μ) indicate the outlines of a figure sometimes called the Milk-Dipper, which is very evident when the eye has once recognized it. On either side of the upturned handle of this dipper-like figure lie some of the most interesting objects in the sky. Let us take the star μ for a starting-point. Sweep downward and to the right a little way, and you will be startled by a most singular phenomenon that has suddenly made its appearance in the field of view of your glass. You may, perhaps, be tempted to congratulate yourself on having got ahead of all the astronomers, and discovered a comet. It is really a combination of a star-cluster with a nebula, and is known as 8 M. Sir John Herschel has described the "nebulous folds and masses" and dark oval gaps which he saw in this nebula with his large telescope at the Cape of Good Hope. But no telescope is needed to make it appear a wonderful object; an opera-glass suffices for that, and a field-glass reveals still more of its marvelous structure.

On the opposite side of the star μ—that is to say, above and a little to the left—is an entirely different but almost equally attractive spectacle, the swarm of stars called 24 M. Here, again, the field-glass easily shows its superiority over the opera-glass, for magnifying power is needed to bring out the innumerable little twinklers of which the cluster is composed. But, whether you use an opera-glass or a field-glass, do not fail to gaze long and steadily at this island of stars, for much of its beauty becomes evident only after the eye has accustomed itself to disentangle the glimmering rays with which the whole field of view is filled. Try the method of averted vision, and hundreds of the finest conceivable points of light will seem to spring into view out of the depths of the sky. The necessity of a perfectly clear night, and the absence of moonlight, can not be too much insisted upon for

observations such as these. Everybody knows how the moonlight blots out the smaller stars. A slight haziness, or smoke, in the air produces a similar effect. It is as important to the observer with an opera-glass to have a transparent atmosphere as it is to one who would use a telescope; but, fortunately, the work of the former is not so much interfered with by currents of air. Always avoid the neighborhood of any bright light. Electric lights in particular are an abomination to star-gazers.

The cloud of stars we have just been looking at is in a very rich region of the Milky-Way, in the little modern constellation called "Sobieski's Shield," which we have not placed upon our map. Sweeping slowly upward from 24 M. a little way with the field-glass, we will pass in succession over three nebulous-looking spots. The second of these, counting upward, is the famous Horseshoe nebula. Its wonders are beyond the reach of our instrument, but its place may be recognized. Look carefully all around this region, and you will perceive that the old gods, who traveled this road (the Milky-Way was sometimes called the pathway of the gods), trod upon golden sands. Off a little way to the east you will find the rich cluster called 25 M. But do not imagine the thousands of stars that your opera-glass or field-glass reveals comprise all the riches of this Golconda of the heavens. You might ply the powers of the greatest telescope in a vain attempt to exhaust its wealth. As a hint of the wonders that lie hidden here, let me quote Father Secchi's description of a starry spot in this same neighborhood, viewed with the great telescope at Rome. After telling of "beds of stars superposed upon one another," and of the wonderful geometrical arrangement of the larger stars visible in the field, he adds:

"The greater number are arranged in spiral arcs, in which one can count as many as ten or twelve stars of the ninth to the tenth magnitude following one another in a curve, like beads upon a string. Sometimes they form rays which seem to diverge from a common focus, and, what is very singular, one usually finds, either at the center of the rays, or at the beginning of the curve, a more brilliant star of a red color, which seems to lead the march. It is impossible to believe that such an arrangement can be accidental."

The reader will recall the somewhat similar description that Admiral Smyth and Mr. Webb have given of a star-cluster in Gemini (see "Popular Science Monthly" for April).

The groups of stars forming the eastern half of the constellation of Sagittarius are worth sweeping over with the glass, as a number of pretty pairs may be found there.

Next let us pass to the double constellation adjoining Scorpio and Sagittarius on the north—Ophiuchus and the Serpent. These constellations, as our map shows, are curiously intermixed. The imagination of the old star-gazers, who named them, saw here the figure of a giant

grasping a writhing serpent with his hands. The head of the serpent is under the Northern Crown, and its tail ends over the star-gemmed region that we have just described, called "Sobieski's Shield." Ophiuchus stands, as figured in Flamsteed's "Atlas," upon the back of the Scorpion, holding the serpent with one hand below the neck, this hand being indicated by the pair of stars marked Epsilon (ϵ) and Delta (δ), and with the other near the tail. The stars Tau (τ) and Nu (ν) indi-

OPHIUCHUS AND SERPENS.

cate the second hand. The giant's face is toward the observer, and the star Alpha (α), also called Ras Alhague, shines in his forehead, while Beta (β) and Gamma (γ) mark his right shoulder. Ophiuchus has been held to represent the famous physician Æsculapius. One may well repress the tendency to smile at these fanciful legends when he reflects upon their antiquity. There is no doubt that this double constellation is at least three thousand years old—that is to say, for thirty centuries the imagination of men has continued to shape these stars into the figures of a gigantic man struggling with a huge serpent. If it possesses no other interest, then it at least has that which attaches to all things ancient. Like many other of the constellations it has proved longer-lived than the mightiest nations. While Greece flour-

ished and decayed, while Rome rose and fell, while the scepter of civilization has passed from race to race, these starry creations of fancy have shone on unchanged. The mind that would ignore them now deserves compassion.

The reader will observe a little circle in the map, and near it the figures 1604. This indicates the spot where one of the most famous temporary stars on record appeared in the year 1604. At first it was far brighter than any other star in the heavens; but it quickly faded, and in a little over a year disappeared. It is particularly interesting, because Kepler—the quaintest, and not far from the greatest, figure in astronomical history—wrote a curious book about it. Some of the philosophers of the day argued that the sudden outburst of the wonderful star was caused by the chance meeting of atoms. Kepler's reply was characteristic, as well as amusing:

"I will tell those disputants, my opponents, not my own opinion, but my wife's. Yesterday, when I was weary with writing, my mind being quite dusty with considering these atoms, I was called to supper, and a salad I had asked for was set before me. 'It seems, then,' said I, aloud, 'that if pewter dishes, leaves of lettuce, grains of salt, drops of water, vinegar and oil, and slices of egg, had been flying about in the air from all eternity, it might at last happen by chance that there would come a salad.' 'Yes,' says my wife, 'but not so nice and well-dressed as this of mine is.'"

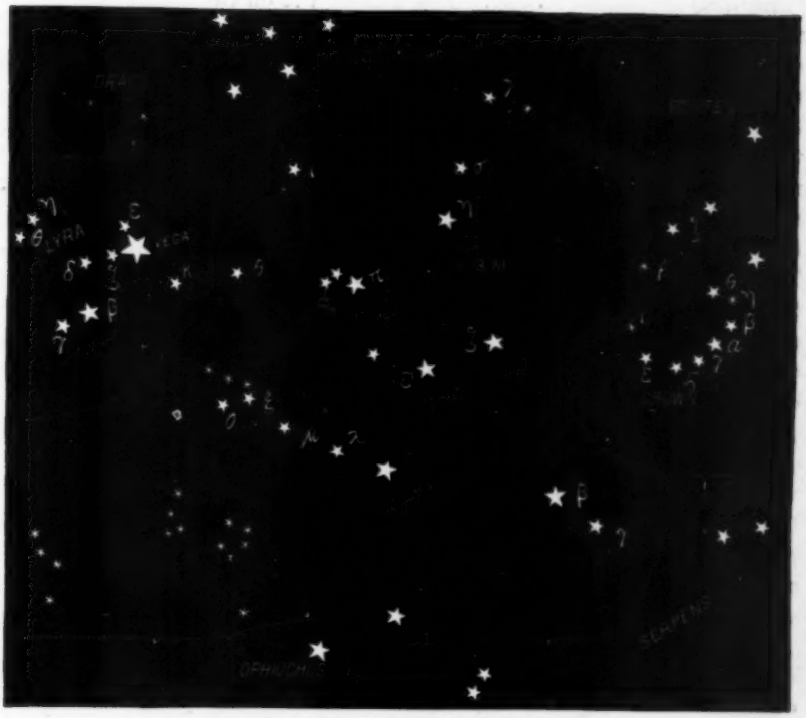
While there are no objects of special interest for the observer with an opera-glass in Ophiuchus, he will find it worth while to sweep over it for what he may pick up, and, in particular, he should look at the group of stars southeast of β and γ. These stars have been shaped into a little modern asterism called Taurus Poniatowskii, and it will be noticed that five of them mark the outlines of a letter V, resembling the well-known figure of the Hyades.

Also look at the stars in the head of Serpens, several of which form a figure like a letter X. A little west of Theta (θ), in the tail of Serpens, is a beautiful swarm of little stars, upon which a field-glass may be used with advantage. The star θ is itself a beautiful double, just within the separating power of a very powerful field-glass under favorable circumstances, the component stars being only about one third of a minute apart.

Do not fail to notice the remarkable subdivisions of the Milky-Way in this neighborhood. Its current seems divided into numerous channels and bays, interspersed with gaps that might be likened to islands, and the star θ appears to be situated upon one of these islands of the galaxy. This complicated structure of the Milky-Way extends downward to the horizon, and upward through the constellation Cygnus, and of its phenomenal appearance in that region we shall have more to say farther on.

Directly north of Ophiuchus is the constellation Hercules, interest-

ing as occupying that part of the heavens toward which the proper motion of the sun in space is bearing the earth and its fellow planets, at the rate, probably, of not less than 160,000,000 miles in a year—a stupendous voyage through space, of whose destination we are as ignorant as the crew of a ship sailing under sealed orders, and, like whom, we must depend upon such inferences as we can draw from courses and distances, for no other information comes to us from the flag-ship of our squadron.



HERCULES, LYRA, AND THE NORTHERN CROWN.

In the accompanying map we have represented the beautiful constellations Lyra and the Northern Crown, lying on either side of Hercules. The reader should note that the point overhead in this map is not far from the star Eta (η) in Hercules. The bottom of the map is toward the south, the right-hand side is west, and the left-hand side east. It is important to keep these directions in mind, in comparing the map with the sky. For instance, the observer must not expect to look into the south and see Hercules half-way up the sky, with Lyra a little east of it; he must look for Hercules nearly overhead, and Lyra a little east of the zenith. The same precautions are not necessary in using the maps of Scorpio, Sagittarius, and Ophiuchus, because those constellations are nearer the horizon, and so the observer does not have to imagine the map as being suspended over his head.

The name Hercules sufficiently indicates the mythological origin of the constellation, and yet the Greeks did not know it by that name, for Aratus calls it "the Phantom whose name none can tell." The Northern Crown, according to fable, was the celebrated crown of Ariadne, and Lyra was the harp of Orpheus himself.

With the aid of the map you will be able to recognize the principal stars and star-groups in Hercules, and will find many interesting combinations of stars for yourself. An object of special interest is the celebrated star-cluster 13 M. You will find it on the map between the stars Eta (η) and Zeta (ζ). While an opera-glass will only show it as a faint and minute speck, lying nearly between two little stars, it is nevertheless well worth looking for, on account of the great renown of this wonderful congregation of stars. Sir William Herschel computed the number of stars contained in it as about fourteen thousand. It is roughly spherical in shape, though there are many straggling stars around it evidently connected with the cluster. In short, it is *a ball of suns*. The reader should not mistake what that implies, however. These suns, though truly solar bodies, are probably very much smaller than our sun. Mr. Gore has recently computed their average diameter to be about forty-five thousand miles, and the distance separating one from another to be 9,000,000,000 miles. Adopting Mr. Gore's estimates of their size and distance, I have recently shown, in a newspaper article, that, as seen from the center of the cluster, the nearest stars would shine about fourteen hundred times as bright as Sirius, while even the farthest stars in the cluster would be much brighter than Sirius, so that a world situated there would enjoy a sort of perpetual daylight, the illumination of its nocturnal sky being, perhaps, as much as fifteen times greater than the light shed from the full moon upon the earth.

If you have a field-glass, by all means try it upon 13 M. It will give you a more satisfactory view than an opera-glass is capable of doing, and will magnify the cluster so that there can be no possibility of mistaking it for a star. Compare this compact cluster, which only a powerful telescope can partially resolve into its component stars, with 7 M. and 24 M., described above, in order to comprehend the wide variety in the structure of these aggregations of stars.

The Northern Crown, although a strikingly beautiful constellation to the naked eye, offers few attractions to the opera-glass. Let us turn, then, to Lyra. I have never been able to make up my mind which of three great stars is entitled to precedence—Vega, the leading brilliant of Lyra, Arcturus in Boötes, or Capella in Auriga. They are the three leaders of the northern firmament, but which of them should be called the chief, is very hard to say. At any rate, Vega would probably be generally regarded as the most beautiful, on account of the delicate bluish tinge in its light, especially when viewed with a glass. There is no possibility of mistaking this star on account of

its surprising brilliancy. Two faint stars close to Vega on the east make a beautiful little triangle with it, and thus form a further means of recognition, if any were needed. Your opera-glass will show that the floor of heaven is powdered with stars, fine as the dust of a diamond, all around the neighborhood of Vega, and the longer you gaze the more of these diminutive twinklers you will discover.

Now direct your glass to the northernmost of the two little stars near Vega, the one marked Epsilon (ε) in the map. You will perceive that it is composed of two stars of almost equal magnitude. If you had a telescope of considerable power, you would find that each of these stars is in turn double. In other words, this wonderful star which appears single to the unassisted eye, is in reality quadruple, and there is reason to think that the four stars composing it are connected in pairs, the members of each pair revolving around their common cen-

VIRGO AND BOÖTES.

ter while the two pairs in turn circle around a center common to all. With a field-glass you will be able to see that the other star near Vega, Zeta (ζ), is also double, the distance between its components being three quarters of a minute, while the two stars in ε are a little

less than 3½′. The star Beta (β) is remarkably variable in brightness. You may watch these variations, which run through a regular period of about 12 days, 21¼ hours, for yourself. The star will be at its minimum of brightness on June 7th and 20th; July 3d, 15th, and 28th; August 10th and 23d. Between Beta and Gamma (γ) lies the beautiful Ring nebula, but it is hopelessly beyond the reach of the optical means we are employing.

Let us turn next to the stars in the west. In consulting the accompanying map of Virgo and Boötes, the observer is supposed to face the southwest, at the hours and dates mentioned above as those to which the circular map corresponds. He will then see the bright star Spica in Virgo not far above the horizon, while Arcturus will be half-way up the sky, and the Northern Crown will be near the zenith. The planet Jupiter will be close to Spica, and will completely outshine it. In fact, during the whole summer, this fine star will be to a considerable extent robbed of its brilliance by the proximity of the great planet. The reader may find it convenient to mark the place of Jupiter on the map just to the left of Spica.

The constellation Virgo is an interesting one in mythological story. Aratus tells us that the Virgin's home was once on earth, where she bore the name of Justice and in the golden age all men obeyed her. In the silver age her visits to men became less frequent, "no longer finding the spirits of former days"; and, finally, when the brazen age came with the clangor of war:

> "Justice, loathing that race of men,
> Winged her flight to heaven; and fixed
> Her station in that region
> Where still by night is seen
> The Virgin goddess near to bright Boötes."

The chief star of Virgo, Spica, is remarkable for its pure white light. To my eye there is no conspicuous star in the sky equal to it in this respect, and it gains in beauty when viewed with a glass. With the aid of the map the reader will find the celebrated binary star Gamma (γ) Virginis, although he will not be able to separate its components without a telescope. It is a curious fact that the star Epsilon (ε) in Virgo has for many ages been known as the Grape-Gatherer. It has borne this name in Greek, in Latin, in Persian, and in Arabic, the origin of the appellation undoubtedly being that it was observed to rise just before the sun in the season of the vintage. It will be observed that the stars ε, δ, γ, η, and β, mark two sides of a quadrilateral figure of which the opposite corner is indicated by Denebola in the tail of Leo. Within this quadrilateral lies the marvelous Field of the Nebulæ, a region where with adequate optical power one may find hundreds of these strange objects thronging together, a very storehouse of the germs of suns and worlds. Unfortunately, these nebulæ are far be-

yond the reach of an opera-glass, but it is worth while to know where this curious region is, even if we can not behold the wonders it contains. The stars Omicron (o), Pi (π), etc., forming a little group, mark the head of Virgo.

The constellation Libra, lying between Virgo and Scorpio, does not contain much to attract our attention. Its two chief stars, α and β, may be readily recognized west of and above the head of Scorpio. The upper one of the two, β, has a singular greenish tint, and the lower one, α, is a very pretty double for an opera-glass.

BERENICE'S HAIR.

Just north of Virgo's head will be seen the glimmering of Berenice's Hair. This little constellation was included among those described in the article on "The Stars of Spring," but it is worth looking at again in the early summer, on moonless nights, and we give here a picture of its stars as seen with a good glass. The singular arrangement of the brighter members of the cluster at once strikes the eye.

Boötes, whose leading brilliant, Arcturus, occupies the center of our map, also possesses a curious mythical history. It was called by the Greeks the Bear-Driver, because it seems continually to chase Ursa Major, the Great Bear, in his path around the pole. The story is that Boötes was the son of the nymph Calisto, whom Juno in one of her customary fits of jealousy turned into a bear. Boötes, who had become a famous hunter, one day roused a bear from her lair, and not knowing that it was his mother, was about to kill her, when Jupiter came to the rescue and snatched them both up into the sky, where they have shone ever since. How this story remained in men's minds is shown by Lucan's reference to it when, describing Brutus's visit to Cato at night, he fixes the time by the position of these constellations in the heavens:

> "'Twas when the solemn dead of night came on,
> When bright Calisto, with her shining son,
> Now half the circle round the pole had run."

Boötes is not specially interesting for our purposes, except for the splendor of Arcturus. This star has possessed a peculiar charm for me ever since boyhood, when, having read a description of it in an old treatise on Uranography I felt an eager desire to see it. As my search for it chanced to begin at a season when Arcturus did not rise till after a boy's bed-time, I was for a long time disappointed, and I

shall never forget the start of surprise and almost of awe with which I finally caught sight of it, one spring evening, shooting its flaming rays through the boughs of an apple-orchard, like a star on fire.

When near the horizon, Arcturus has a remarkably reddish color; but, after it has attained a high elevation in the sky, it appears rather a deep yellow than red. There is a scattered cluster of small stars surrounding Arcturus, forming an admirable spectacle with an opera-glass on a clear night. To see these stars well, the glass should be slowly moved about. Many of them are hidden by the glare of Arcturus. The little group of stars near the handle of the end of the Great Dipper, or, what is the same thing, the tail of the Great Bear, marks the upraised hand of Boötes. Between Berenice's Hair and the tail of the Bear you will see a small constellation called Canes Venatici, the Hunting-Dogs. On the old star-maps Boötes is represented as holding these dogs with a leash, while they are straining in chase of the Bear. You will find some pretty groupings of stars in this constellation.

And now we will turn to the east. Our next map shows Cygnus, a constellation especially remarkable for the large and striking figure that it contains, called the Northern Cross, Aquila the Eagle, the Dolphin, and the little asterisms Sagitta and Vulpecula. In consulting the map, the observer is supposed to face toward the east. In Aquila the curious arrangement of two stars on either side of the chief star of the constellation, called Altair, at once attracts the eye. Within a circle including the two attendants of Altair you will probably be able to see with the naked eye only two or three stars in addition to the three large ones. Now turn your glass upon the same spot, and you will see eight or ten times as many stars, and with a field-glass still more can be seen. Watch the star marked Eta (η), and you will find that its light is variable, being sometimes more than twice as bright as at other times. Its changes are periodical, and occupy a little over a week.

This Eagle is fabled to have been the bird that Jupiter kept beside his throne. A constellation called Antinous, invented by Tycho Brahe, is represented on some maps as occupying the lower portion of the space given to Aquila.

The Dolphin is an interesting little constellation, and the ancients said it represented the very animal on whose back the famous musician Arion rode through the sea after his escape from the sailors who tried to murder him. But some modern has dubbed it with the less romantic name of Job's Coffin, by which it is sometimes called. It presents a very pretty sight to the opera-glass.

Cygnus, the Swan, is a constellation whose mythological history is somewhat obscure, although, as remarked above, it contains one of the most clearly marked figures to be found among the stars, the famous Northern Cross. The outlines of this cross are marked with great

distinctness by the stars Alpha (α), Epsilon (ε), Gamma (γ), Delta (δ), and Beta (β), together with some fainter stars lying along the main beam of the cross between β and γ. The star β, also called Albireo, is one of the most beautiful double stars in the heavens. The components are sharply contrasted in color, the larger star being golden-

CYGNUS, AQUILA, THE DOLPHIN, ETC.

yellow, while the smaller one is a deep, rich blue. With a field-glass of 1·6-inch aperture and magnifying full six times I have sometimes been able to divide this pair, and to recognize the blue color of the smaller star. It will be found a severe test for such a glass.

About half way from Albireo to the two stars ζ and ε in Aquila, is a very curious little group consisting of six or seven stars in a straight row, with a garland of other stars hanging from the center. To see it best, take a field-glass, although an opera-glass shows it.

I have indicated the place of the celebrated star 61 Cygni in the map, because of the interest attaching to it as the nearest to us, so far as we know, of all the stars in the northern hemisphere, and with one exception the nearest star in all the heavens. Yet it is very faint, and the fact that so inconspicuous a star should be nearer than such brill-

iants as Vega and Arcturus shows how wide is the range of magnitude among the suns that light the universe. The actual distance of 61 Cygni is something like 650,000 times as great as the distance from the earth to the sun.

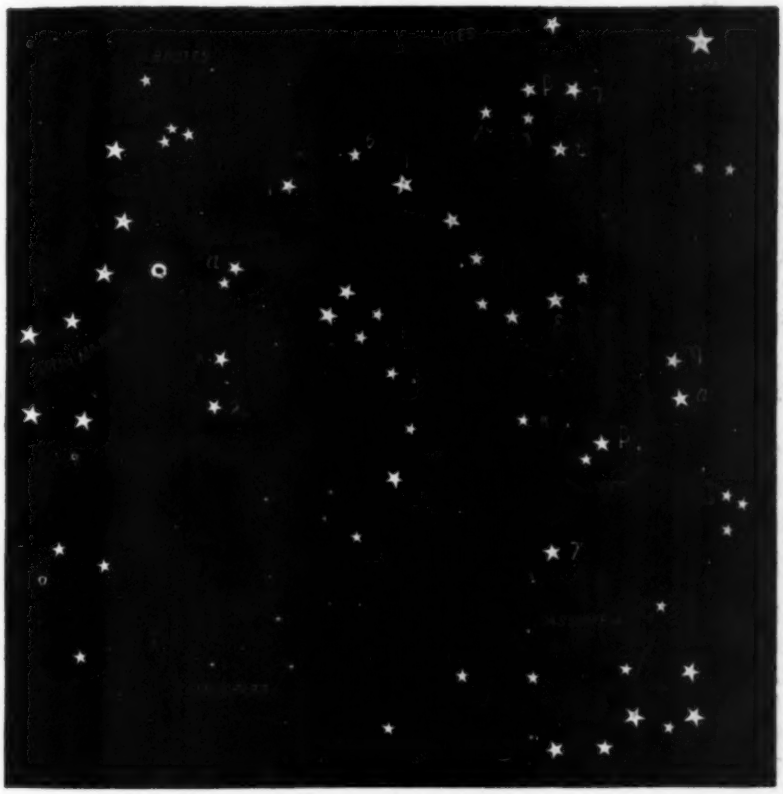
The star Omicron (*o*) is very interesting with an opera-glass. The naked eye sees a little star near it. The glass throws them wide apart, and divides *o* itself into two stars. Now, a field-glass, if of sufficient power, will divide the larger of these stars again into two—a fine test.

Sweep around α and γ for the splendid star-fields that abound in this neighborhood; also around the upper part of the figure of the cross. We are here in one of the richest parts of the Milky-Way. Between the stars α, γ, ϵ, is the strange dark gap in the galaxy called the Coal-Sack, a sort of hole in the starry heavens. Although it is not entirely empty of stars, its blackness is striking in contrast with the brilliancy of the Milky-Way in this neighborhood. The divergent streams of the great river of light in this region present a very remarkable appearance.

Finally, we come to the great dragon of the sky. In using the map of Draco and the neighboring constellations, the reader is supposed to face the north. The upper edge of the center of the map is directly over the observer's head. One of the stories told of this large constellation is that it represents a dragon that had the temerity to war against Minerva. The goddess "seized it in her hand, and hurled it, twisted as it was, into the heavens round the axis of the world, before it had time to unwind its contortions." Others say it is the dragon that guarded the golden apples in the Garden of the Hesperides, and that was slain by the redoubtable Hercules. At any rate, it is plainly a monster of the first magnitude. The stars β, γ, ξ, ν, and μ represent its head, while its body runs trailing along, first sweeping in a long curve toward Cepheus, and then bending around and passing between the two bears. Try ν with your opera-glass, and if you succeed in seeing it double you may congratulate yourself on your keen sight. The distance between the stars is about 1′. Notice the contrasted colors of γ and β, the former being a rich orange and the latter white. As you sweep along the winding way that Draco follows, you will run across many striking fields of stars, although the heavens are not as rich here as in the splendid regions that we have just left. You will also find that Cepheus, although not an attractive constellation to the naked eye, is worth some attention with an opera-glass. It, however, sinks into insignificance in comparison with its neighbor Cassiopeia, but that constellation belongs rather to the autumn sky, and we shall pass it by here.

The reader will find it both interesting and instructive to watch the movements of Venus through the summer. On June 1st as we have seen, Venus will be near Saturn in the constellation Gemini. But

the two planets will rapidly part company, Saturn sinking toward the horizon day by day until it is no longer seen, while Venus, moving eastwardly, rises higher every evening. About the middle of July, Venus, having reached her greatest eastern elongation, will turn upon



DRACO AND ITS NEIGHBORS.

her track and move westwardly, setting a little earlier every night. At the middle of August she will attain her greatest brilliancy, and will be a superb phenomenon. Being then in that part of her orbit which passes between the earth and the sun, her illuminated disk will be in the form of a crescent. A good field-glass, under favorable circumstances, will show this crescent form of Venus, and a most beautiful sight it is. The crescent will grow larger and narrower in proportion as Venus approaches nearer to the line joining the earth and the sun, and, as she approaches that line, of course she will draw closer to the horizon, until about the end of August, she disappears from the evening sky, to reappear in the east as a morning-star in the autumn.

Jupiter will remain in the neighborhood of Spica in Virgo throughout the summer. The surface features of this majestic planet are far beyond the reach of an opera- or field-glass, but some of the

members of his little family of four moons may occasionally be caught sight of. With an opera-glass not more than one or two of these can be seen as excessively minute dots of light half-hidden in the glare of the planet. If you succeed under favorable circumstances in seeing one of these moons with your glass, you will be all the more astonished to learn that there are several apparently well-authenticated instances of one of the moons of Jupiter having been seen with the naked eye.

JUPITER AND HIS MOONS. (Seen with a field-glass; power, six diameters.)

With a field-glass, however, you will have no difficulty in seeing all of the moons when they are properly situated. If you miss one or more of them, you may know that it is either between you and the planet, or behind the planet, or buried in the planet's shadow, or else so close to the planet as to be concealed by its radiance. For the convenience of the beginner, I will indicate the positions of Jupiter's moons for several evenings in June, based upon the "Nautical Almanac" predictions; the time of observation is supposed to be 10.30 o'clock P. M.:

On June 1st all four satellites will be visible with a good field-glass, one being on the eastern and the other three on the western side of the planet, two of the latter appearing close together like a double star.

On June 2d the satellites will all be on the western side, two of them being pretty close to the planet and also close together, while the others are more distant and wide apart.

On June 6th all four will be on the eastern side of Jupiter, and three of them, besides being near the planet, will be close together in a slanting row. It will require close watching with a fine glass to see them all, but the spectacle will be well worth some painstaking on the part of the observer.

On June 8th two will be on one side and two on the other, the two on the west being close together, while those on the east are widely separated.

On June 14th two will be close together on the east, while one is visible on the west, and the fourth, the outermost of the system, is passing just above the north pole of the planet, and so close that it will probably be beyond the ability even of a powerful field-glass to detect it.

On June 17th there will be a very good opportunity for the inexperienced observer to see all four of the satellites, as two will be on each side of the planet and all will be well separated.

On June 22d one satellite will be on the east of Jupiter, and the other three on the west, all in a bunch, and close to the planet.

Of course, since the motions of the satellites, particularly of the inner ones, are very rapid, their positions are continually changing, and their configurations are different every night. I have merely indicated their places for a few evenings, in order that the observer may be able to recognize the satellites when he sees them. If he has any doubt about his identification of them, or thinks they may be little stars, he has only to carefully note their position and then look at them again the next evening. He may even notice their motion in the course of a single evening, if he begins early and follows them for three or four hours.

SCIENCE AND PSEUDO-SCIENCE.

By Professor T. H. HUXLEY.

IN the opening sentences of a contribution to the last number of this Review, the Duke of Argyll has favored me with a lecture on the proprieties of controversy, to which I should be disposed to listen with more docility if his Grace's precepts appeared to me to be based upon rational principles, or if his example were more exemplary.

With respect to the latter point, the duke has thought fit to entitle his article "Professor Huxley on Canon Liddon," and thus forces into prominence an element of personality which those who read the paper which is the object of the duke's animadversions will observe I have endeavored, most carefully, to avoid. My criticisms dealt with a report of a sermon, published in a newspaper, and thereby addressed to all the world. Whether that sermon was preached by A or B was not a matter of the smallest consequence; and I went out of my way to absolve the learned divine to whom the discourse was attributed from the responsibility for statements which, for anything I knew to the contrary, might contain imperfect, or inaccurate, representations of his views. The assertion that I had the wish or was beset by any "temptation to attack" Canon Liddon is simply contrary to fact.

But suppose that if, instead of sedulously avoiding even the appearance of such attack, I had thought fit to take a different course; suppose that, after satisfying myself that the eminent clergyman whose name is paraded by the Duke of Argyll had really uttered the words attributed to him from the pulpit of St. Paul's, what right would any one have to find fault with my action on grounds either of justice, expediency, or good taste?

Establishment has its duties as well as its rights. The clergy of a state Church enjoy many advantages over those of unprivileged and unendowed religious persuasions, but they lie under a correlative

responsibility to the state, and to every member of the body politic. I am not aware that any sacredness attaches to sermons. If preachers stray beyond the doctrinal limits set by lay lawyers, the Privy Council will see to it; and, if they think fit to use their pulpits for the promulgation of literary, or historical, or scientific errors, it is not only the right, but the duty, of the humblest layman, who may happen to be better informed, to correct the evil effects of such perversion of the opportunities which the state affords them and such misuse of the authority which its support lends them. Whatever else it may claim to be, in its relations with the state, the Established Church is a branch of the civil service; and, for those who repudiate the ecclesiastical authority of the clergy, they are merely civil servants, as much responsible to the English people for the proper performance of their duties as any others.

The Duke of Argyll tells us that the "work and calling" of the clergy prevent them from "pursuing disputation as others can." I wonder if his Grace ever reads the so-called religious newspapers? It is not an occupation which I should commend to any one who wishes to employ his time profitably; but a very short devotion to this exercise will suffice to convince him that the "pursuit of disputation," carried to a degree of acrimony and vehemence unsurpassed in lay controversies, seems to be found quite compatible with the "work and calling" of a remarkably large number of the clergy.

Finally, it appears to me that nothing can be in worse taste than the assumption that a body of English gentlemen can, by any possibility, desire that immunity from criticism which the Duke of Argyll claims for them. Nothing would be more personally offensive to me than the supposition that I shirked criticism, just or unjust, of any lecture I ever gave. I should be utterly ashamed of myself if, when I stood up as an instructor of others, I had not taken every pains to assure myself of the truth of that which I was about to say; and I should feel myself bound to be even more careful with a popular assembly, who would take me more or less on trust, than with an audience of competent and critical experts.

I decline to assume that the standard of morality, in these matters, is lower among the clergy than it is among scientific men. I refuse to think that the priest who stands up before a congregation as the minister and interpreter of the Divinity is less careful in his utterances, less ready to meet adverse comment, than the layman who comes before his audience as the minister and interpreter of Nature. Yet what should we think of the man of science who, when his ignorance or his carelessness was exposed, whined about the want of delicacy of his critics, or pleaded his "work and calling" as a reason for being let alone?

No man, nor any body of men, is good enough, or wise enough, to dispense with the tonic of criticism. Nothing has done more harm

to the clergy than the practice, too common among laymen, of regarding them, when in the pulpit, as a sort of chartered libertines, whose divagations are not to be taken seriously. And I am well assured that the distinguished divine, to whom the sermon is attributed, is the last person who would desire to avail himself of the dishonoring protection which has been superfluously thrown over him.

So much for the lecture on propriety. But the Duke of Argyll, to whom the hortatory style seems to come naturally, does me the honor to make my sayings the subjects of a series of other admonitions, some on philosophical, some on geological, some on biological topics. I can but rejoice that the duke's authority in these matters is not always employed to show that I am ignorant of them; on the contrary, I meet with an amount of agreement, even of approbation, for which I proffer such gratitude as may be due, even if that gratitude is sometimes almost overshadowed by surprise.

I am unfeignedly astonished to find that the Duke of Argyll, who professes to intervene on behalf of the preacher, does really, like another Balaam, bless me altogether in respect of the main issue.

I denied the justice of the preacher's ascription to men of science of the doctrine that miracles are incredible, because they are violations of natural law; and the Duke of Argyll says that he believes my "denial to be well founded. The preacher was answering an objection which has now been generally abandoned." Either the preacher knew this or he did not know it. It seems to me, as a mere lay teacher, to be a pity that the "great dome of St. Paul's" should have been made to "echo" (if so be that such stentorian effects were really produced) a statement which, admitting the first alternative, was unfair, and, admitting the second, was ignorant.*

Having thus sacrificed one half of the preacher's arguments, the Duke of Argyll proceeds to make equally short work with the other half. It appears that he fully accepts my position that the occurrence of those events, which the preacher speaks of as catastrophes, is no evidence of disorder, inasmuch as such catastrophes may be necessary occasional consequences of uniform changes. Whence I conclude, his Grace agrees with me, that the talk about royal laws "wrecking" ordinary laws may be eloquent metaphor, but is also nonsense.

* The Duke of Argyll speaks of the recent date of the demonstration of the fallacy of the doctrine in question. "Recent" is a relative term, but I may mention that the question is fully discussed in my book on "Hume," which, if I may believe my publishers, has been read by a good many people since it appeared in 1879. Moreover, I observe, from a note at page 89 of "The Reign of Law," a work to which I shall have occasion to advert by-and-by, that the Duke of Argyll draws attention to the circumstance that, so long ago as 1866, the views which I hold on this subject were well known. The duke, in fact, writing about this time, says, after quoting a phrase of mine, "The question of miracles seems now to be admitted on all hands to be simply a question of evidence." In science we think that a teacher who ignores views which have been discussed *coram populo* for twenty years, is hardly up to the mark.

And now comes a further surprise. After having given these superfluous stabs to the slain body of the preacher's argument, my good ally remarks, with magnificent calmness, "So far, then, the preacher and the professor are at one. . . . Let them smoke the calumet." By all means: smoke would be the most appropriate symbol of this wonderful attempt to cover a retreat. After all, the duke has come to bury the preacher, not to praise him; only he makes the funeral obsequies look as much like a triumphal procession as possible.

So far as the questions between the preacher and myself are concerned, then, I may feel happy. The authority of the Duke of Argyll is ranged on my side. But the duke has raised a number of other questions, with respect to which I fear I shall have to dispense with his support—nay even be compelled to differ from him as much as or more than I have done about his Grace's new rendering of the "benefit of clergy."

In discussing catastrophes, the duke indulges in statements, partly scientific, partly anecdotic, which appear to me to be somewhat misleading. We are told, to begin with, that Sir Charles Lyell's doctrine respecting the proper mode of interpreting the facts of geology (which is commonly called uniformitarianism) "does not hold its head quite so high as it once did." That is great news indeed. But is it true? All I can say is that I am aware of nothing that has happened of late that can in any way justify it; and my opinion is, that the body of Lyell's doctrine, as laid down in that great work, "The Principles of Geology," whatever may have happened to its head, is a chief and permanent constituent of the foundations of geological science.

But this question can not be advantageously discussed, unless we take some pains to discriminate between the essential part of the uniformitarian doctrine and its accessories; and it does not appear that the Duke of Argyll has carried his studies of geological philosophy so far as this point. For he defines uniformitarianism to be the assumption of the "extreme slowness and perfect continuity of all geological changes."

What "perfect continuity" may mean in this definition, I am by no means sure; but I can only imagine that it signifies the absence of any break in the course of natural order during the millions of years, the lapse of which is recorded by geological phenomena.

Is the Duke of Argyll prepared to say that any geologist of authority, at the present day, believes that there is the slightest evidence of the occurrence of supernatural intervention, during the long ages of which the monuments are preserved to us in the crust of the earth? And if he is not, in what sense has this part of the uniformitarian doctrine, as he defines it, lowered its pretensions to represent scientific truth?

As to the "extreme slowness of all geological changes," it is simply a popular error to regard that as, in any wise, a fundamental and

necessary dogma of uniformitarianism. It is extremely astonishing to me that any one who has carefully studied Lyell's great work can have so completely failed to appreciate its purport, which yet is "writ large" on the very title-page: "The Principles of Geology, being an Attempt to explain the Former Changes of the Earth's Surface by Reference to Causes now in Operation." The essence of Lyell's doctrine is here written so that those who run may read; and it has nothing to do with the quickness or slowness of the past changes of the earth's surface, except in so far as existing analogous changes may go on slowly, and therefore create a presumption in favor of the slowness of past changes.

With that epigrammatic force which characterizes his style, Buffon wrote, nearly a hundred and fifty years ago, in his famous "Théorie de la Terre," "Pour juger de ce qui est arrivé, et même de ce qui arrivera, nous n'avons qu'à examiner ce qui arrive." The key of the past, as of the future, is to be sought in the present, and only when known causes of change have been shown to be insufficient have we any right to have recourse to unknown causes. Geology is as much an historical science as archæology; and I apprehend that all sound historical investigation rests upon this axiom. It underlay all Hutton's work, and animated Lyell and Scrope in their successful efforts to revolutionize the geology of half a century ago.

There is no antagonism whatever, and there never was, between the belief in the views which had their chief and unwearied advocate in Lyell and the belief in the occurrence of catastrophes. The first edition of Lyell's "Principles," published in 1830, lies before me, and a large part of the first volume is occupied by an account of volcanic, seismic, and diluvial catastrophes which have occurred within the historical period. Moreover, the author over and over again expressly draws the attention of his readers to the consistency of catastrophes with his doctrine:

> Notwithstanding, therefore, that we have not witnessed within the last three thousand years the devastation by deluge of a large continent, yet, as we may predict the future occurrence of such catastrophes, we are authorized to regard them as part of the present order of Nature, and they may be introduced into geological speculations respecting the past, provided that we do not imagine them to have been more frequent or general than we expect them to be in time to come (vol. i, p. 89).

Again:

> If we regard each of the causes separately, which we know to be at present the most instrumental in remodeling the state of the surface, we shall find that we must expect each to be in action for thousands of years, without producing any extensive alterations in the habitable surface, and then to give rise, during a very brief period, to important revolutions (vol. ii, p. 161).*

* See also vol. i, p. 460. In the ninth edition (1853), published twenty-three years after the first, Lyell deprives even the most careless reader of any excuse for misunder-

Lyell quarreled with the catastrophists, then, by no means because they assumed that catastrophes occur and have occurred, but because they had got into the habit of calling on their god Catastrophe to help them when they ought to have been putting their shoulders to the wheel of observation of the present course of Nature, in order to help themselves out of their difficulties. And geological science has become what it is chiefly because geologists have gradually accepted Lyell's doctrine and followed his precepts.

So far as I know anything about the matter, there is nothing that can be called proof, that the causes of geological phenomena operated more intensely or more rapidly at any time between the older Tertiary and the oldest Palæozoic epochs than they have done between the older Tertiary epoch and the present day. And if that is so, uniformitarianism, even as limited by Lyell,* has no call to lower its crest. But, if the facts were otherwise, the position Lyell took up remains impregnable. He did not say that the geological operations of Nature were never more rapid, or more vast, than they are now; what he did maintain is the very different proposition that there is no good evidence of anything of the kind. And that proposition has not yet been shown to be incorrect.

I owe more than I can tell to the careful study of the "Principles of Geology" in my young days; and, long before the year 1856, my mind was familiar with the truth that "the doctrine of uniformity is not incompatible with great and sudden changes," which, as I have shown, is taught *totidem verbis* in that work. Even had it been possible for me to shut my eyes to the sense of what I had read in the "Principles," Whewell's "Philosophy of the Inductive Sciences," published in 1840, a work with which I was also tolerably familiar, must have opened them. For the always acute, if not always profound, author, in arguing against Lyell's uniformitarianism, expressly points out that it does not in any way contravene the occurrence of catastrophes.

standing him: "So in regard to subterranean movements, the theory of the perpetual uniformity of the force which they exert on the earth-crust is quite consistent with the admission of their alternate development and suspension for indefinite periods within limited geographical areas" (p. 187).

* A great many years ago ("Presidential Address to the Geological Society," 1869) I ventured to indicate that which seemed to me to be the weak point, not in the fundamental principles of uniformitarianism, but in uniformitarianism as taught by Lyell. It lay, to my mind, in the refusal by Hutton, and in a less degree by Lyell, to look beyond the limits of the time recorded by the stratified rocks. I said: "This attempt to limit, at a particular point, the progress of inductive and deductive reasoning from the things which are to the things which were—this faithlessness to its own logic—seems to me to have cost uniformitarianism the place as the permanent form of geological speculation which it might otherwise have held" ("Lay Sermons," p. 260). The context shows that "uniformitarianism" here means that doctrine, as limited in application by Hutton and Lyell, and that what I mean by "evolutionism" is consistent and thoroughgoing uniformitarianism.

With regard to such occurrences [earthquakes, deluges, etc.], terrible as they appear at the time, they may not much affect the average rate of change: there may be a *cycle*, though an irregular one, of rapid and slow change; and if such cycles go on succeeding each other, we may still call the order of Nature uniform, notwithstanding the periods of violence which it involves.*

The reader who has followed me through this brief chapter of the history of geological philosophy, will probably find the following passage in the paper of the Duke of Argyll to be not a little remarkable:

Many years ago, when I had the honor of being President of the British Association,† I ventured to point out, in the presence and in the hearing of that most distinguished man [Sir C. Lyell] that the doctrine of uniformity was not incompatible with great and sudden changes, since cycles of these and other cycles of comparative rest might well be constituent parts of that uniformity which he asserted. Lyell did not object to this extended interpretation of his own doctrine, and, indeed, expressed to me his entire concurrence.

I should think he did; for, as I have shown, there was nothing in it that Lyell himself had not said six-and-twenty years before, and enforced three years before; and it is almost verbally identical with the view of uniformitarianism taken by Whewell, sixteen years before, in a work with which one would think that any one who undertakes to discuss the philosophy of science should be familiar.

Thirty years have elapsed since the beginner of 1856 persuaded himself that he enlightened the foremost geologist of his time, and one of the most acute and far-seeing men of science of any time, as to the scope of the doctrines which the veteran philosopher had grown gray in promulgating; and the Duke of Argyll's acquaintance with the literature of geology has not, even now, become sufficiently profound to dissipate that pleasant delusion.

If the Duke of Argyll's guidance in that branch of physical science, with which alone he has given evidence of any practical acquaintance, is thus unsafe, I may breathe more freely in setting my opinion against the authoritative deliverances of his Grace about matters which lie outside the province of geology.

And here the duke's paper offers me such a wealth of opportunities that choice becomes embarrassing. I must bear in mind the good old adage "non multa sed multum." Tempting as it would be to follow the duke through his labyrinthine misunderstandings of the ordinary terminology of philosophy, and to comment on the curious unintelligibility which hangs about his frequent outpourings of fervid language, limits of space oblige me to restrict myself to those points, the discussion of which may help to enlighten the public in respect of matters of more importance than the competence of my Mentor for the task which he has undertaken.

I am not sure when the employment of the word Law, in the sense

* "Philosophy of the Inductive Sciences," vol. i, p. 670. New edition, 1847.

† At Glasgow in 1856.

in which we speak of laws of Nature, commenced, but examples of it may be found in the works of Bacon, Descartes, and Spinoza. Bacon employs "law" as the equivalent of "form," and I am inclined to think that he may be responsible for a good deal of the confusion that has subsequently arisen; but I am not aware that the term is used by other authorities, in the seventeenth and eighteenth centuries, in any other sense than that of "rule" or "definite order" of the coexistence of things or succession of events in Nature. Descartes speaks of "règles, que je nomme les lois de la nature." Leibnitz says "loi ou règle générale," as if he considered the terms interchangeable.

The Duke of Argyll, however, affirms that the "law of gravitation" as put forth by Newton was something more than the statement of an observed order. He admits that Kepler's three laws "were an observed order of facts and nothing more." As to the law of gravitation, "it contains an element which Kepler's laws did not contain, even an element of causation, the recognition of which belongs to a higher category of intellectual conceptions than that which is concerned in the mere observation and record of separate and apparently unconnected facts." There is hardly a line in these paragraphs which appears to me to be indisputable. But, to confine myself to the matter in hand, I can not conceive that any one who had taken ordinary pains to acquaint himself with the real nature of either Kepler's or Newton's work could have written them. That the labors of Kepler, of all men in the world, should be called "mere observation and record," is truly wonderful. And any one who will look into the "Principia," or the "Optics," or the "Letters to Bentley," will see, even if he has no more special knowledge of the topics discussed than I have, that Newton over and over again insisted that he had nothing to do with gravitation as a physical cause, and that when he used the terms attraction, force, and the like, he employed them, as he says, "*mathematicè*" and not "*physicè*."

> How these attractions [of gravity, magnetism, and electricity] may be performed, I do not here consider. What I call attraction may be performed by impulse or by some other means unknown to me. I use that word here to signify only in a general way any force by which bodies tend toward one another, whatever be the cause.*

According to my reading of the best authorities upon the history of science, Newton discovered neither gravitation nor the law of gravitation; nor did he pretend to offer more than a conjecture as to the causation of gravitation. Moreover, his assertion that the notion of a body acting where it is not, is one that no competent thinker could entertain, is antagonistic to the whole current conception of attractive and repulsive forces, and therefore of "the attractive force of gravitation." What, then, was that labor of unsurpassed magnitude and excellence and immortal influence which Newton did perform?

* "Optics," query 31.

In the first place, Newton defined the laws, rules, or observed order of the phenomena of motion, which come under our daily observation, with greater precision than had been before attained; and, by following out with marvelous power and subtilty the mathematical consequences of these rules, he almost created the modern science of pure mechanics. In the second place, applying exactly the same method to the explication of the facts of astronomy as that which was applied a century and a half later to the facts of geology by Lyell, he set himself to solve the following problem: Assuming that all bodies, free to move, tend to approach one another as the earth and the bodies on it do; assuming that the strength of that tendency is directly as the mass and inversely as the squares of the distances; assuming that the laws of motion, determined for terrestrial bodies, hold good throughout the universe; assuming that the planets and their satellites were created and placed at their observed mean distances, and that each received a certain impulse from the Creator—will the form of the orbits, the varying rates of motion of the planets, and the ratio between those rates and their distances from the sun which must follow by mathematical reasoning from these premises, agree with the order of facts determined by Kepler and others, or not?

Newton, employing mathematical methods which are the admiration of adepts, but which no one but himself appears to have been able to use with ease, not only answered this question in the affirmative, but stayed not his constructive genius before it had founded modern physical astronomy.

The historians of mechanical and of astronomical science appear to be agreed that he was the first person who clearly and distinctly put forth the hypothesis that the phenomena comprehended under the general name of "gravity" follow the same order throughout the universe, and that all material bodies exhibit these phenomena; so that, in this sense, the idea of universal gravitation may, doubtless, be properly ascribed to him.

Newton proved that the laws of Kepler were particular consequences of the laws of motion and the law of gravitation—in other words, the reason of the first lay in the two latter. But to talk of the law of gravitation, alone, as the reason of Kepler's laws, and still more as standing in any causal relation to Kepler's laws, is simply a misuse of language. It would really be interesting if the Duke of Argyll would explain how he proposes to set about showing that the elliptical form of the orbits of the planets, the constant area described by the radius vector, and the proportionality of the squares of the periodic times to the cubes of the distances from the sun, are either caused by the "force of gravitation" or deducible from the "law of gravitation." I conceive that it would be about as apposite to say that the various compounds of nitrogen with oxygen are caused by chemical attraction and deducible from the atomic theory.

Newton assuredly lent no shadow of support to the modern pseudo-scientific philosophy which confounds laws with causes. I have not taken the trouble to trace out this commonest of fallacies to its first beginning; but I was familiar with it in full bloom, more than forty years ago, in a work which had a great vogue in its day—the "Vestiges of the Natural History of Creation"—of which the first edition was published in 1844.

It is full of apt and forcible illustrations of pseudo-scientific realism. Consider, for example, this gem serene: When a boy who has climbed a tree looses his hold of the branch, "the law of gravitation unrelentingly pulls him to the ground, and then he is hurt," whereby the Almighty is quite relieved from any responsibility for the accident. Here is the "law of gravitation" acting as a cause, in a way quite in accordance with the Duke of Argyll's conception of it. In fact, in the mind of the author of the "Vestiges," "laws" are existences intermediate between the Creator and his works, like the "ideas" of the Platonizers or the Logos of the Alexandrians.* I may cite a passage which is quite in the vein of Philo:

> We have seen powerful evidences that the construction of this globe and its associates, and, inferentially, that of all the other globes in space, was the result, not of any immediate or personal exertion on the part of the Deity, but of natural laws which are the expression of his will. What is to hinder our supposing that the organic creation is also a result of natural laws which are in like manner an expression of his will? (p. 154, first edition).

And creation "operating by law" is constantly cited as relieving the Creator from trouble about insignificant details.

I am perplexed to picture to myself the state of mind which accepts these verbal juggleries. It is intelligible that the Creator should operate according to such rules as he might think fit to lay down for himself (and, therefore, according to law); but that would leave the operation of his will just as much a direct personal act as it would be under any other circumstances. I can also understand that (as in Leibnitz's caricature of Newton's views) the Creator might have made the cosmical machine, and, after setting it going, have left it to itself till it needed repair. But then, by the supposition, his personal responsibility would have been involved in all that it did, just as much as a dynamiter is responsible for what happens when he has set his machine going and left it to explode.

The only hypothesis which gives a sort of mad consistency to the Vestigiarian's views is the supposition that laws are a kind of angels or demiurgoi, who, being supplied with the Great Architect's plan, were permitted to settle the details among themselves. Accepting this doctrine, the conception of royal laws and plebeian laws, and of these more than Homeric contests in which the big laws "wreck" the

* The author recognizes this in his "Explanations."

little ones, become quite intelligible. And, in fact, the honor of the paternity of those remarkable ideas which come into full flower in the preacher's discourse must, so far as my imperfect knowledge goes, be attributed to the author of the "Vestiges."

But the author of the "Vestiges" is not the only writer who is responsible for the current pseudo-scientific mystifications which hang about the term "law." When I wrote my paper about "Scientific and Pseudo-Scientific Realism," I had not read a work by the Duke of Argyll, "The Reign of Law," which, I believe, has enjoyed, possibly still enjoys, a wide-spread popularity. But the vivacity of the duke's attack led me to think it possible that criticisms directed elsewhere might have come home to him. And, in fact, I find that the second chapter of the work in question, which is entitled "Law; its Definitions," is, from my point of view, a sort of "summa" of pseudo-scientific philosophy. It will be worth while to examine it in some detail.

In the first place, it is to be noted that the author of the "Reign of Law" admits that "law," in many cases, means nothing more than the statement of the order in which facts occur, or, as he says, "an observed order of facts" (p. 66). But his appreciation of the value of accuracy of expression does not hinder him from adding, almost in the same breath, "In this sense the laws of Nature are simply those facts of Nature which recur according to rule" (p. 66). Thus "laws," which were rightly said to be the statement of an order of facts in one paragraph, are declared to be the facts themselves in the next.

We are next told that, though it may be customary and permissible to use "law" in the sense of a statement of the order of facts, this is a low use of the word; and indeed, two pages farther on, the writer, flatly contradicting himself, altogether denies its admissibility:

> An observed order of facts, to be entitled to the rank of a law, must be an order so constant and uniform as to indicate necessity, and necessity can only arise out of the action of some compelling force (p. 68).

This is undoubtedly one of the most singular propositions that I have ever met with in a professedly scientific work, and its rarity is embellished by another direct self-contradiction which it implies. For, on the preceding page (67), when the Duke of Argyll is speaking of the laws of Kepler, which he admits to be laws, and which are types of that which men of science understand by "laws," he says that they are "simply and purely an order of facts." Moreover, he adds, "A very large proportion of the laws of every science are laws of this kind and in this sense."

If, according to the Duke of Argyll's admission, law is understood in this sense, thus widely and constantly, by scientific authorities, where is the justification for his unqualified assertion that such statements of the observed order of facts are not "entitled to the rank" of laws?

But let us examine the consequences of the really interesting proposition I have just quoted. I presume that it is a law of Nature that "a straight line is the shortest distance between two points." This law affirms the constant association of a certain fact of form with a certain fact of dimension. Whether the notion of necessity which attaches to it has an *a priori* or an *a posteriori* origin is a question not relevant to the present discussion. But I would beg to be informed, if it is necessary, where is the "compelling force" out of which the necessity arises; and, further, if it is not necessary, whether it loses the character of a law of Nature?

I take it to be a law of Nature, based on unexceptionable evidence, that the mass of matter remains unchanged, whatever chemical or other modifications it may undergo. This law is one of the foundations of chemistry. But it is by no means necessary. It is quite possible to imagine that the mass of matter should vary according to circumstances, as we know its weight does. Moreover, the determination of the "force" which makes mass constant (if there is any intelligibility in that form of words) would not, so far as I can see, confer any more validity on the law than it has now.

There is a law of Nature, so well vouched by experience that all mankind, from pure logicians in search of examples to parish sextons in search of fees, confide in it. This is the law that "all men are mortal." It is simply a statement of the observed order of facts that all men sooner or later die. I am not acquainted with any law of Nature which is more "constant and uniform" than this. But will any one tell me that death is "necessary"? Certainly there is no *a priori* necessity in the case, for various men have been imagined to be immortal. And I should be glad to be informed of any "necessity" that can be deduced from biological considerations. It is quite conceivable, as has recently been pointed out, that some of the lowest forms of life may be immortal, after a fashion. However this may be, I would further ask, supposing "all men are mortal" to be a real law of Nature, where and what is that to which, with any propriety, the title of "compelling force" of the law can be given?

On page 69, the Duke of Argyll asserts that the law of gravitation "is a law in the sense not merely of a rule but of a cause." But this revival of the teaching of the "Vestiges" has already been examined and disposed of; and, when the Duke of Argyll states that the "observed order," which Kepler had discovered, was simply a necessary consequence of the force of "gravitation," I need not recapitulate the evidence which proves such a statement to be wholly fallacious. But it may be useful to say once more that, at this present moment, nobody knows anything about the existence of a force of gravitation apart from the fact; that Newton declared the ordinary notion of such force to be inconceivable; that various attempts have been made to account for the order of facts we call gravitation, without recourse to the no-

tion of attractive force; that, if such a force exists, it is utterly incompetent to account for Kepler's laws, without taking into the reckoning a great number of other considerations; and, finally, that all we know about the "force" of gravitation, or any other so-called "force," is that it is a name for the hypothetical cause of an observed order of facts.

Thus, when the Duke of Argyll says, "Force, ascertained according to some measure of its operation—this is, indeed, one of the definitions, but only one, of a scientific law" (p. 71), I reply that it is a definition which must be repudiated by every one who possesses an adequate acquaintance with either the facts or the philosophy of science, and relegated to the limbo of pseudo-scientific fallacies. If the human mind had never entertained this notion of "force," nay, if it substituted bare, invariable succession for the ordinary notion of causation, the idea of law, as the expression of a constantly observed order, which generates a corresponding intensity of expectation in our minds, would have exactly the same value, and play its part in real science, exactly as it does now.

It is needless to extend further the present excursus on the origin and history of modern pseudo-science. Under such high patronage as it has enjoyed, it has grown and flourished, until, nowadays, it is becoming somewhat rampant. It has its weekly "Ephemerides," in which every new pseudo-scientific mare's-nest is hailed and belauded with the unconscious unfairness of ignorance; and an army of "reconcilers," enlisted in its service, whose business seems to be to mix the black of dogma and the white of science into the neutral tint of what they call liberal theology.

I remember that, not long after the publication of the "Vestiges," a shrewd and sarcastic countryman of the author defined it as "cauld kail made het again." A cynic might find amusement in the reflection that, at the present time, the principles and the methods of the much-vilified Vestigiarian are being "made het again"; and are not only "echoed by the dome of St. Paul's," but thundered from the castle of Inverary. But my turn of mind is not cynical, and I can but regret the waste of time and energy bestowed on the endeavor to deal with the most difficult problems of science, by those who have neither undergone the discipline, nor possess the information which are indispensable to the successful issue of such an enterprise.

I have already had occasion to remark that the Duke of Argyll's views of the conduct of controversy are different from mine; and this much-to-be-lamented discrepancy becomes yet more accentuated when the duke reaches biological topics. Anything that was good enough for Sir Charles Lyell, in his department of study, is certainly good enough for me in mine; and I by no means demur to being pedagogically instructed about a variety of matters with which it has been the business of my life to try to acquaint myself. But the Duke of Argyll

is not content with favoring me with his opinions about my own business; he also answers for mine; and, at that point, really the worm must turn. I am told that "no one knows better than Professor Huxley" a variety of things which I really do not know; and I am said to be a disciple of that "Positive Philosophy" which I have, over and over again, publicly repudiated in language which is certainly not lacking in intelligibility, whatever may be its other defects.

I am told that I have been amusing myself with a "metaphysical exercitation or logomachy" (may I remark incidentally that these are not quite convertible terms?), when, to the best of my belief, I have been trying to expose a process of mystification, based upon the use of scientific language by writers who exhibit no sign of scientific training, of accurate scientific knowledge, or of clear ideas respecting the philosophy of science, which is doing very serious harm to the public. Naturally enough, they take the lion's skin of scientific phraseology for evidence that the voice which issues from beneath it is the voice of Science, and I desire to relieve them from the consequences of their error.

The Duke of Argyll asks, apparently with sorrow that it should be his duty to subject me to reproof:

> What shall we say of a philosophy which confounds the organic with the inorganic, and, refusing to take note of a difference so profound, assumes to explain, under one common abstraction, the movements due to gravitation and the movements due to the mind of man?

To which I may fitly reply by another question: What shall we say to a controversialist who attributes to the subject of his attack opinions which are notoriously not his; and expresses himself in such a manner that it is obvious he is unacquainted with even the rudiments of that knowledge which is necessary to the discussion into which he has rushed?

What line of my writing can the Duke of Argyll produce which confounds the organic with the inorganic?

As to the latter half of the paragraph, I have to confess a doubt whether it has any definite meaning. But I imagine that the duke is alluding to my assertion that the law of gravitation is nowise "suspended" or "defied" when a man lifts his arm; but that, under such circumstances, part of the store of energy in the universe operates on the arm at a mechanical advantage as against the operation of another part. I was simple enough to think that no one who had as much knowledge of physiology as is to be found in an elementary primer, or who had ever heard of the greatest physical generalization of modern times—the doctrine of the conservation of energy—would dream of doubting my statement; and I was further simple enough to think that no one who lacked these qualifications would feel tempted to charge me with error. It appears that my simplicity is greater than my powers of imagination.

The Duke of Argyll may not be aware of the fact, but it is nevertheless true, that when a man's arm is raised, in sequence to that state of consciousness we call a volition, the volition is not the immediate cause of the elevation of the arm. On the contrary, that operation is effected by a certain change of form, technically known as "contraction" in sundry masses of flesh, technically known as muscles, which are fixed to the bones of the shoulder in such a manner that, if these muscles contract, they must raise the arm. Now, each of these muscles is a machine, in a certain sense, comparable to one of the donkey-engines of a steamship, but more complete, inasmuch as the source of its ability to change its form, or contract, lies within itself. Every time that, by contracting, the muscle does work, such as that involved in raising the arm, more or less of the material which it contains is used up, just as more or less of the fuel of a steam-engine is used up, when it does work. And I do not think there is a doubt in the mind of any competent physicist or physiologist that the work done in lifting the weight of the arm is the mechanical equivalent of a certain proportion of the energy set free by the molecular changes which take place in the muscle. It is further a tolerably well-based belief that this, and all other forms of energy, are mutually convertible, and therefore that they all come under that general law or statement of the order of facts called the conservation of energy. And, as that certainly is an abstraction, so the view which the Duke of Argyll thinks so extremely absurd is really one of the commonplaces of physiology. But this Review is hardly an appropriate place for giving instruction in the elements of that science, and I content myself with recommending the Duke of Argyll to devote some study to Book II, Chapter V, section 4, of my friend Dr. Foster's excellent "Text-Book of Physiology" (first edition, 1877, p. 321), which begins thus:

> Broadly speaking, the animal body is a machine for converting potential into actual energy. The potential energy is supplied by the food; this the metabolism of the body converts into the actual energy of heat and mechanical labor.

There is no more difficult problem in the world than that of the relation of the state of consciousness, termed volition, to the mechanical work which frequently follows upon it. But no one can even comprehend the nature of the problem who has not carefully studied the long series of modes of motion which, without a break, connect the energy which does that work with the general store of energy. The ultimate form of the problem is this: Have we any reason to believe that a feeling, or state of consciousness, is capable of directly affecting the motion of even the smallest conceivable molecule of matter? Is such a thing even conceivable? If we answer these questions in the negative, it follows that volition may be a sign, but can not be a cause of bodily motion. If we answer them in the affirmative, then states of consciousness become undistinguishable from material things;

for it is the essential nature of matter to be the vehicle or substratum of mechanical energy.

There is nothing new in all this. I have merely put into modern language the issue raised by Descartes more than two centuries ago. The philosophies of the Occasionalists, of Spinoza, of Malebranche, of modern idealism and modern materialism, have all grown out of the controversies which Cartesianism evoked. Of all this the pseudo-science of the present time appears to be unconscious; otherwise it would hardly content itself with "making het again" the pseudo-science of the past.

In the course of these observations I have already had occasion to express my appreciation of the copious and perfervid eloquence which enriches the Duke of Argyll's pages. I am almost ashamed that a constitutional insensibility to the Sirenian charms of rhetoric has permitted me, in wandering through these flowery meads, to be attracted almost exclusively to the bare places of fallacy and the stony grounds of deficient information which are disguised, though not concealed, by these floral decorations. But, in his concluding sentences, the duke soars into a Tyrtæan strain which roused even my dull soul:

> It was high time, indeed, that some revolt should be raised against that Reign of Terror which had come to be established in the scientific world under the abuse of a great name. Professor Huxley has not joined this revolt openly, for as yet, indeed, it is only beginning to raise its head. But more than once—and very lately—he has uttered a warning voice against the shallow dogmatism that has provoked it. The time is coming when that revolt will be carried further. Higher interpretations will be established. Unless I am much mistaken, they are already coming in sight (p. 339).

I have been living very much out of the world for the last two or three years, and when I read this denunciatory outburst, as of one filled with the spirit of prophecy, I said to myself: "Mercy upon us! what has happened? Can it be that X and Y (it would be wrong to mention the names of the vigorous young friends which occurred to me) are playing Danton and Robespierre; and that a guillotine is erected in the court-yard of Burlington House for the benefit of all anti-Darwinian Fellows of the Royal Society? Where are the secret conspirators against this tyranny, whom I am supposed to favor, and yet not have the courage to join openly? And to think of my poor oppressed friend, Mr. Herbert Spencer, 'compelled to speak with bated breath' (p. 338) certainly for the first time in my thirty-odd years' acquaintance with him!" My alarm and horror at the supposition that, while I had been fiddling (or at any rate physicking), my beloved Rome had been burning, in this fashion, may be imagined.

I am sure the Duke of Argyll will be glad to hear that the anxiety he created was of extremely short duration. It is my privilege to have access to the best sources of information, and nobody in the scientific world can tell me anything about either the Reign of Ter-

ror or the Revolt. In fact, the scientific world laughs most indecorously at the notion of the existence of either; and some are so lost to the sense of the scientific dignity, that they descend to the use of transatlantic slang, and call it a "bogus scare." As to my friend Mr. Herbert Spencer, I have every reason to know that, in the "Factors of Organic Evolution," he has said exactly what was in his mind, without any particular deference to the opinions of the person whom he is pleased to regard as his most dangerous critic and devil's advocate-general, and still less of any one else.

I do not know whether the Duke of Argyll pictures himself as the Tallien of this imaginary revolt against a no less imaginary Reign of Terror. But if so, I most respectfully but firmly decline to join his forces. It is only a few weeks since I happened to read over again the first article which I ever wrote (now twenty-seven years ago) on the "Origin of Species," and I found nothing that I wished to modify in the opinions that are there expressed, though the subsequent vast accumulation of evidence in favor of Mr. Darwin's views would give me much to add. As is the case with all new doctrines, so with that of evolution, the enthusiasm of advocates has sometimes tended to degenerate into fanaticism, and mere speculation has, at times, threatened to shoot beyond its legitimate bounds. I have occasionally thought it wise to warn the more adventurous spirits among us against these dangers, in sufficiently plain language; and I have sometimes jestingly said that I expected, if I lived long enough, to be looked on as a reactionary by some of my more ardent friends. But nothing short of midsummer madness can account for the fiction that I am waiting till it is safe to join openly a revolt, hatched by some person or persons unknown, against an intellectual movement with which I am in the most entire and hearty sympathy. It is a great many years since, at the outset of my career, I had to think seriously what life had to offer that was worth having. I came to the conclusion that the chief good, for me, was freedom to learn, think, and say what I pleased, when I pleased. I have acted on that conviction, and have availed myself of the "rara temporum felicitas ubi sentire quæ velis, et quæ sentias dicere licet," which is now enjoyable, to the best of my ability; and though strongly, and perhaps wisely, warned that I should probably come to grief, I am entirely satisfied with the results of the line of action I have adopted.

My career is at an end—

> I have warmed both hands at the fire of life;

and nothing is left me, before I depart, but to help, or at any rate to abstain from hindering, the younger generation of men of science in doing better service to the cause we have at heart, than I have been able to render.

And yet, forsooth, I am supposed to be waiting for the signal of "revolt," which some fiery spirits among these young men are to raise

before I dare express my real opinions concerning questions about which we older men had to fight, in the teeth of fierce public opposition and obloquy—of something which might almost justify even the grandiloquent epithet of a Reign of Terror—before our excellent successors had left school.

It would appear that the spirit of pseudo-science has impregnated even the imagination of the Duke of Argyll. The scientific imagination always restrains itself within the limits of probability.—*Nineteenth Century.*

GOFIO: FOOD AND PHYSIQUE.

By C. FAYETTE TAYLOR, M. D.

ON a recent visit to the Canary Islands, one of the first things to attract my notice was the good development and fine personal appearance of the common people. I afterward found that travelers are generally impressed in the same manner on their first visit to the Canaries. If they have previously visited the Spanish Peninsula, they are apt to contrast the native Spaniards with their Canarian relatives, always in favor of the latter, whose greater height and better bodily forms are very evident. This superiority may be due, in a certain degree, to the admixture of the Spanish blood with that of the Guanche race, which was found in possession, when, in 1440, the Spanish undertook the conquest of the Canarian Archipelago. It required more than fifty years for the purpose, and not until, to the utmost efforts of Spain, then in the height of her power, the treachery of four native kings had been added, did all the seven islands come under Spanish rule. The old chroniclers are fond of describing the mild and sweet dispositions of the Guanches, their tall, manly figures, and noble bearing in time of peace, as well as their great strength and valor when fighting to preserve their ancient liberty.

Even the women took part against the invaders, and proved themselves, in daring and prowess, no mean antagonists. One woman is especially mentioned who rushed upon an advancing column, seized the foremost soldier and fled up the mountain, bearing her victim as if he had been a child, outstripping her pursuers, till, coming to a precipice, she leaped down and both were dashed to pieces.

The conquerors not only mingled their blood with the conquered, as happens with the Latin races, but they adopted many of their customs, some of which are preserved to the present time. Perhaps the most important of these is in relation to their food, the principal article of which is of Guanche origin.

I have alluded to the excellent bodily development and proportions of the modern Canarians, and to the testimony left by the old chroniclers to the still fine characteristics of the ancient Guanches, who are

indeed described as marvels of bodily strength, beauty, and agility, because these facts have an important bearing on the question of their food. As there can be no such bodily growth, strength, and activity, as is described as belonging to these people, without superior nourishment, it follows that the food used by the Guanches, and adopted and still almost exclusively used by the present inhabitants, must be highly nutritious.

This article, so evidently important, is the *gofio*, named at the head of this paper. There is nothing mysterious about it, for gofio is simply flour made from any of the cereals by parching or roasting before grinding. The Guanches may have roasted their wheat, barley, etc., by the ready method of first heating stones, on which or among which the grain was afterward placed. As to that there are no precise accounts, but well-shaped grinding-stones are plentifully preserved. At present gofio is prepared by roasting the grain in a broad, shallow earthen dish, over a charcoal-fire. It is kept constantly stirred, to prevent burning. One can hardly pass through a village or hamlet without witnessing some stage of the preparation of gofio. The grain is first carefully picked over and all impurities removed. The processes frequently take place in front of or just within the always-open door, giving the traveler ample opportunity to see all steps of the preparation. The grinding is done at the wind-mills, which abound everywhere. The roasted grain is ground to a very fine flour, when it becomes gofio. After grinding it is ready for immediate use. When it is to be eaten, milk, soup, or any suitable fluid, may be mixed with it—anything, in fact, to give it sufficient consistency to be conveyed into the mouth. Being already cooked, it requires no further preparation before eating.

Ultimately maize was introduced into the islands, and soon became an article of general cultivation, particularly on the Island of Grand Canary, where gofio from it is the staple article of food for the laboring population, as that from wheat or wheat mixed with maize is in Teneriffe, wheat being more largely grown in the latter island. Gofio is also made from barley, and especially in Fuerteventura. It is also made from Spanish beans; but this kind is not used alone, but to mix in the proportion of about one fourth to three fourths of wheat, barley, or maize gofio, as some prefer. Wheat and corn gofio, mixed in equal proportions, is very much used, and is preferred by many to either article alone. Nothing can exceed the extreme handiness of this ready-cooked article of food. The Canarian laborer, if alone, takes some gofio in a bag made of the stomach of a kid; if there are several persons, the skin of a kid is used. When the hour for the simple meal has arrived, the bag is extracted from some pocket, or, likely enough, from the girdle, and putting a little water into it, after being well shaken, the meal is ready. Only enough water is added to make it sufficiently consistent to be readily taken in the hand, from which it is invariably

eaten. The preparation occupies no appreciable time. The winter before last I saw one or two hundred Italian workmen repairing the retaining wall to a river, and had reason to admire both their industry and their simple, frugal habits. As the mid-day hour approached, one of a gang of ten or twelve men would step aside and prepare the dinner. It nearly always consisted of *polenta*, or Indian-corn meal boiled in water. It took the best part of an hour to prepare it, and there was also the trouble of kettles, fires, providing wood, besides many antecedent preparations, even when cooking was thus reduced to its simplest proportions. The Canarian laborer has no such trouble. The roasting of the grain is more quickly done than cooking polenta, and can be prepared in larger quantity by the wife at home.

The grinding is the same in both cases, but gofio has the great advantage of being easily carried about the person in a bag, and is always ready to be eaten. It is also much more palatable. The Canarian Archipelago consists of seven inhabited islands with a population of two hundred and forty thousand persons. From the best information I could get, I should think that fully two hundred thousand of them live almost exclusively on gofio, as their fathers have done before them, including their Guanche predecessors, from time immemorial. I have been thus particular in giving, in some detail, the origin, preparation, and importance of gofio in sustaining a large population, because I believe this article to be worthy of attention on the part of purveyers of farinaceous foods. If introduced into the United States, it would add a delicious, wholesome, and highly nutritious article of food, very convenient to use, to our already large variety. But gofio has other claims to our attention and favor than its economy, convenience, and evident highly nutritive qualities.

Finding it used, not only by the common people, for whom it constitutes the chief article of sustenance as already stated, but also in the homes of the wealthier citizens, children being especially fond of and thriving well on it, I tried specimens of both wheat and maize gofio and found them very palatable—the maize especially so, having a delicious, aromatic flavor which soon made me prefer it to bread, especially in the morning. Very soon gofio, with a soft-boiled egg, goat's milk, and coffee, constituted a satisfactory breakfast. In fact, I liked it so well, and found it so digestible and nutritious, that I kept to it and throve on it till, at the end of two months, it occurred to me that during that time there had been no instance of "acid stomach" to which, in the best of times, I had always been subject. I left Teneriffe soon after, and during the voyage, and for some time after landing in the West Indies, the gofio-breakfast was suspended. After some weeks without it, the acidity returned very severely, owing to exposure and fatigue. And, as usual, acidity once established, persistently continued. After suffering several days I thought of the gofio, a small quantity of which we had brought from Teneriffe. On

eating it for breakfast, as I had done before, the acidity immediately disappeared and has not returned.

In this connection I would say that I had previously observed the same phenomenon of complete exemption from acid stomach while using Carlsbad Zwieback, as the sole farinaceous food at breakfast. Zwieback, as most persons already know, is bread cut in thick slices and baked a second time. In Carlsbad the second baking is carried so far that the slice is browned through its entire thickness. If there remains a white central portion it is not good, and will undergo acid decomposition in the dyspeptic stomach when the properly made Zwieback will remain for a long time unchanged except by gastric fluids. But, while useful as a temporary expedient, Zwieback has not much nutrition after undergoing the three processes of raising, baking, and rebaking to incipient carbonizing. It is incapable of being used alone as a sufficient aliment. To gofio there is no such objection. The roasting is the first and only cooking of the food. Gofio is a food dry cooked, no fluid coming to it till the very moment of eating it; and we know that dry heat produces changes in the structure and composition of cereals different from those produced by moist heat. The roasting process is essentially different from the steaming, baking, or boiling process, and, for one thing, converts starchy particles into more soluble and more friable forms. Moderately browned bread-crust illustrates the change produced.

Perhaps the roasting process has a protecting efficacy against the action of the ferments which are always present in the alimentary tract, ready to effect some form of decomposition should digestion be long enough delayed to allow them to act. In fact, there is no doubt that, in many cases, the stomach actually becomes a receptacle for the cultivation of microbes. As one meal after the other is taken into the stomach, each succeeding mass of fermentable material is affected by the ferment-germs developed and energized by those which have preceded it, till a high degree of potency is reached as in the usual method of bacteria cultivation. In such a case normal digestion is anticipated by fermentation, the wholesomeness of the food is impaired by antecedent decomposition, the gastric power is lessened by contact with noxious acids and gases, and we have the confirmed dyspeptic. The worst of it is, that such a condition is self-propagating, all ordinary means failing to energize digestion or to de-energize the ferment that the former may precede the latter in the usual way. Even the useful and often indispensable stomach-pump sometimes fails to prevent prompt fermentation of the first food taken after its careful use for cleansing purposes. In all my previous personal and professional experience, I found, when once the rapid acidulation of the food demonstrated the potentialization of the microbic ferment, there was no so sure way to overcome it as, in turn, to energize the digestive action by prolonged abstinence from food. In that case the ferment becomes

itself digested and de-energized and acts more slowly than the digestive process.

After this the ever-present but now non-energized ferment-germs act tardily, till some accident of overdoing, or bad eating, or other cause, again delays digestion till fermentation is set up in the gastric cavity, and the cultivation process above described is renewed, when there is another attack of acidity of the stomach, difficult to bear and difficult to get rid of, as every unfortunate dyspeptic and every unfortunate physician to such a patient full well know to their sorrow. But the starving-out process is not easy, and is not applicable in many cases; besides, not every one has the resolution for it, when it might be proper and effective. If, in gofio, already demonstrated to have the essentials of high nutrition and palatableness, we have an article of food capable of resisting the acid decomposition for a much longer time than the ordinary preparations of farinacea, it will be an inestimable boon to all civilized communities to make the fact known to them.

I have set on foot trials of the value of gofio, in such cases as are appropriate, to carefully determine its influence in preventing gastric acidity. Whether the impressions, formed, as above described, after several months' personal experience, are to be sustained or to be found groundless, will be known in due time by ample clinical demonstrations. But, considering the importance of the subject to so many persons, and to the end that experiments in the use of gofio in appropriate cases may be multiplied, I do not hesitate to place my (as yet) unsupported personal experience before the profession and public for their careful consideration.

SOCIAL SUSTENANCE.

II.—COMBINATION OF EFFORT.

By HENRY J. PHILPOTT.

PERHAPS we may now enter on a more detailed examination of the nature and methods of the help that human beings in the social state render one another in making a living. The best way to do this will be to begin with the simple and proceed to the complex. It is all done by the combination of our efforts—not their aggregation simply, but their combination. We must carefully note the difference. Aggregation is a mere pooling of products or results. At any rate, let us so use the word. It may be illustrated by two fishermen fishing on the river-bank with hook and line, and dividing the catch at night. No more fish will be caught than if each fished separately and carried home his own catch.

But suppose they take a seine, they may catch ten times as many

as they could working separately. They have now *combined* their efforts, which before were merely added together. The combination has brought forth a new and enlarged result. It has increased the result geometrically. By uniting and helping each other, they have gained a better living than they could possibly have got by working separately.

This way of uniting human effort let us call combination. But we need not enter into any quibble as to the precise place to draw the line between aggregation and combination. If anybody chooses to confuse the two, no economic argument will be affected one way or the other. If the distinction does not beget clearness of thought, it will have served no purpose whatever, and may be ignored; for, henceforth, we shall mostly be thinking about *combination*, and very seldom of mere pooling or aggregation of effort.

1. The simplest form of combination is where two or more men carry a burden too heavy for either alone, but which can not be divided. Pall-bearers, or the bearers of a sedan-chair, or track-layers on a railroad, or the builders of a log-house, illustrate this extremely simple and direct form of the combination of human effort to bring about a result unattainable by separate effort. Even in this simple form of mutual helpfulness it is plainly seen that two and two do not make four—they make five, or ten, or a hundred.

2. The next most simple form of combination is where two or more persons are working at the same undertaking in the same place, or under the same management, but attending to different parts of it. Every factory, mill, shop, store, or jobbing-house, illustrates this form. There are division and diversity of work, but the product is one. So it is with the players in a play. Their parts are diverse, but the play is a unit, and they all work together. Here it is plainer than ever that ten or fifteen human beings, by combining their efforts, can do for us in three hours what one person could not do in a lifetime.

3. One step more in the direction of complexity, and we reach a form of combination wherein all still contribute to the production of a single article or result, but work in different places, different factories, different countries, perhaps, and especially under different management or conditions. A striking example of this is the cotton-grower, whose immediate product is of extremely little use until it has been transported many miles and been worked upon by another set of human beings, generally of a different race and color. But this is only one example, though perhaps the most striking, of the third form of combination of human effort, in which persons widely separated by space as well as by diversity of gifts and employments, jointly contribute to a single and strictly unified product or result.

It is often a business question with the leader of an enterprise whether he shall adopt the second or third form of combination; and still oftener how far he shall follow one and how far the other. In

some industries the tendency is one way, and in some the other. In still others it is merely a question of how much of the work each contributor shall do. Shall the iron-master buy his iron in the bar, in the pig, or in the ore? Shall the woolen manufacturer buy his wool in the crude web, in the yarn, or in the fleece? Fifty years ago it was quite common for the same family to rear and shear the sheep, wash the fleece, card it, spin it, weave it, color it, and make it into clothing —though different members of the family attended to different parts of the work. That was a combination of the second form. At present wool-growing and woolen-manufacturing are separated. Sometimes the spinning and weaving are separated. As a rule, the weaving and making are separated.

It is into this third form of combination that what is called *exchange* enters. Exchange is so important a phenomenon that political economy is often called the science of exchanges. This definition, as we now see, narrows its field. The real subject-matter of political economy is the mutual helpfulness of human beings in making a living. Exchange is only one of the ways of making this helpfulness effective. None the less, persons between whom exchange is hindered or prohibited are to that extent kept from helping one another to make a living. The wool-grower and the sheep-shearer are just as truly engaged in the production of cloth as the weaver. If the wool-grower is prohibited from furnishing wool to the weaver, it is plain that both are hindered in their joint work.

4. In the fourth form of combination, also, exchange prevails as a prominent feature. But here we take leave of one feature which has thus far characterized all forms of combination. It is *unity of product.* Each party now completes his product, ready to enter into the living of a fellow-being. One hunts and the other fishes, and the hunter trades game for fish. Each then has for his supper a variety consisting of game and fish. Rarely, indeed, is the exchange so simple as this. In civilized societies it is highly complex, and its problems baffle the best of brains. If we sit down to a meal, we find that one set of men have furnished us the table, another set the table-cloth, another the dishes, another the silver, another the bread, another the butter, another the pepper, another the salt, another the sugar, another the coffee, another this, and another that, until a score of groups and thousands of persons might be counted, all of whom have helped us to get our dinner—to make our living.

5. There is a fifth form of combination, more simple than the third or fourth, and yet in one sense more complex. In this the service rendered on one side is direct, and on the other indirect. There is no exchange of products, and, in fact, generally no product. The physician, the minister, the lawyer, the teacher, and the housemaid, all help us in making a living. They do not help us by making some material thing and sending it to us. They help us personally and directly. We in

return help them by giving them the money we have got for helping somebody else, and with it they buy the products or services of still other people.

The doctor helps the lawyer to get well. The lawyer helps the doctor to get something to eat and wear, by giving him some of the money he has got for helping other people to get their rights in the courts.

The mutual help of man and wife is usually in this form. Only in this case there is no stipulated return service for what the wife does, and she gets part of her reward in money and part in goods. She is to have her living—this the law provides. If the case comes into court, the *amplitude* of her living may be fixed, or rather the amplitude of her means of living. Otherwise, she may render a large service for a poor living, or get a good living for no service at all. But whatever service she does render is rendered directly, and it also, like the finished product in the fourth combination, enters immediately into the living of the other party to the mutual helpfulness.

6. There is a sixth combination of human effort, and a very important one. It is the combination of past with successive present efforts. In one form of it the material product of the past effort is called capital. In other forms it is non-material, and is called skill, education, training, reputation, prestige, or good-will. If a fisherman spends a week making a boat, we say he has spent a week accumulating capital. But if he spends five days learning how, and makes the boat in a day, we say he has spent a day in the production of capital. If he spends another week in learning to row it, he has still spent but one day in the accumulation of capital. But, none the less, he has done two weeks' work which will never bear fruit until it is combined with future work, and then it will (presumably) fertilize that future work and increase its fruitage.

So the past work of the dead father is combined with the present work of the living son. This, not only as embodied in the estate which he left him, but as manifested in his education, moral, mental, and manual. This combination links us to the whole past and the whole future. It needs to be very carefully studied.

For instance, the hasty critic may say that it is identical with the third combination, since in that the past labor of the cotton-planter is combined with the present labor of the weaver. But this criticism misses the point. In the third combination we combine the past efforts of others with our own present efforts in a single combination, resulting in a single product or service. In the sixth combination we combine identical past efforts, which may be our own, with a *succession* of our own present efforts, to produce a succession of similar or different products or services. Any individual fiber of cotton, once woven into cloth, and worn, is extinct; but the boat of the fisherman may be used over and over again for fishing, for hunting, for necessary journeys, or for pleasure.

So skill, once acquired, is combined with all future efforts in the same line, or even in slightly different lines.

Care must be taken not to confound our sixth combination with the ideas conveyed by the word "capital." Cotton produced, and not yet woven or worn, is called capital. It is not necessary for us to quarrel with that use of the term. We may use it in the same way without detriment to the clearness of our ideas, or the force of logic. For that matter, we may call anything capital which has been produced and not yet consumed. We shall have only incidental use for the term, and in most cases the ordinary business sense of it will do.

These six forms of the combination of human efforts for the purpose of securing an increase of results more than commensurate with the increase of effort are, like the simple elements in chemistry or the three forms of the lever in mechanics, generally found united or co-working, and in an infinite variety of ways. Thus, as between themselves, the actors in a play exemplify the second combination; as between them and the audience, the combination is of the fifth form. So, in the production of cotton cloth, there is combination in the second form as between the different classes of operatives in the factory, and combination in the third form as between all the factory operatives and all the employés in the cotton-field.

But we plainly see that the sustenance of civilized human beings is the work of a mutual-aid society of stupendous proportions and well-nigh inscrutable complexity. To a rapidly growing extent it takes in the whole world. But the greater the civilization the greater the complexity, and the greater the proportion of mutual helpfulness to immediate self-helpfulness. Hence the greater difficulty, but at the same time the greater necessity, of a thorough study of the methods of this mutual helpfulness, and of the terms on which it is rendered.

To this study I hope to contribute something, and I shall not be disappointed if it is something very far short of a revolution. It may be nothing but the discovery, or selection, or utilization of a new point of view. But even this may enable some fellow-student of taller stature to catch a glimpse of some landmark, or alignment of landmarks, which will prove a key to the whole situation. Political economy has been termed the science of *wealth;* in order to widen the field, "wealth" has been called "weal"; again, it has been called the science of *exchanges*, and again the word "exchanges" has been widened to admit of an evidently needed expansion of treatment. I propose to let these words shrink back to their every-day meaning, and adopt a treatment and a definition of the science which will take in every effect of social relations on individual sustenance of every degree of amplitude. For want of a better term to express this broad view, I have translated "political economy" into "social sustenance." The new term is intended to interpret, and not to supersede, the old one.

I have with extreme brevity outlined the hindrances as well as the helps that socially organized human beings offer us in our sustenance. The latter I have classified into six forms of combination (not always exchange) of effort, as follows :

1. Unity of completed service, immediate union of contributors, homeogeneity of functions.

2. Unity of completed service, immediate union of contributors, specialization of functions.

3. Unity of completed service, specialization of functions, separation of contributors.

4. Diversity of completed service, specialization of functions, separation of contributors, service embodied in material commodities.

5. Diversity of completed services, embodied in commodities on one side only, or neither, specialization of functions, contributors sometimes united (as man and wife) in the final purpose of making a living.

6. Combination of past with successive present efforts, all by the same or by different contributors, completed services personal or embodied in commodities.

Whether the list might be extended, or ought to be condensed, is for others to say. In its present form it can hardly be more than suggestive, for its whole line of study is entirely novel, so far as I know. A rigid adherence to it, however, is not essential to my general view of the science, nor to any part of a minute discussion in accordance with that view. At the same time I am inclined to think that some such classification might be made not only highly instructive, but quite convenient for reference.

INDUSTRIAL EDUCATION AND RAILWAY SERVICE.*

MUCH has been heard, during the discussions of the labor question, about the rights and interests of manufacturers and of workmen, but comparatively very little about the claims of the work. While the contention between manufacturers and their men has always been hot, and sometimes vital, the product of their joint energy, upon the best availability of which for its intended purpose the life of both parties depends, has been left to shift for itself. Producers have relaxed their pains to secure the best possible product, in order that they might put more money into their pockets, or recoup themselves for the losses they have had to suffer by the antagonism of their men ; and workmen have, in obedience to some "union" or "chapter," systematically slighted their work, as one of the means by which they imagined they might get even with the capitalists. The result has been, in

* Abridged from a report by Dr. W. T. Barnard to the President of the Baltimore and Ohio Railroad Company.

England and to some extent in the United States, a falling back in the standard of manufactured products, and decline of trade in them, in favor of those countries in which, as in Germany, excellence and attractiveness in the executed work are recognized as entitled to equal consideration with the capitalist's desire for immediate profits and the workman's championship of "organized labor."

This tendency—for it is still, happily, in the United States a tendency rather than an accomplished fact—has been recognized most quickly by others than the parties who should seem to be most directly interested; and the efforts to counteract it have led to the establishment of several technical and art schools, either as university departments or on independent footings, some of which have proved themselves very efficient.

It has also engaged the attention of a number of manufacturing establishments and other corporations employing large bodies of workmen, who have had the sagacity to perceive that their permanent interests were identified with their turning out the best products. Among these was the Baltimore and Ohio Railroad Company, which in 1881 commended to Dr. W. T. Barnard, assistant to the president, a proposition for the establishment of a technical school for scientific and mechanical instruction, to examine into and report upon. Without waiting for his full report, the company, under Dr. Barnard's management, made a start of such a school in 1885, in connection with its shops at Mount Clare. Dr. Barnard's report has just appeared, and covers a wide ground, including a sketch of the effects of technical education in Europe; a review of its progress and present status in the United States; discussions of the need of more thorough and extended technical instruction in Baltimore, and of the advantages which the Baltimore and Ohio Company, together with other railway interests, would derive from a thorough system of this character; and a programme for inaugurating systematic technical instruction in the service of that company.

To prepare himself more thoroughly for his work, Dr. Barnard, besides studying the subject in books, made personal examinations of the principal existing technical schools in the United States and Europe. The result of this investigation was so to impress him with the vital importance of technical education to the industrial and commercial interests of the United States in general as well as with the particular concerns he at first had in view; and also with the almost universal ignorance of its potency displayed by those whom it would most beneficially affect, that he has deemed it a duty to make his report one that would be generally useful.

"In Europe," says the author, "the necessity of technical education for industrial laborers, felt and freely acknowledged many years ago, was forced into prominence through the increasing rivalry between manufacturers and other producers competing with like articles

in the same markets. In order to counterbalance the advantages which some manufacturers engaged in a given industry enjoyed through the possession of cheaper raw material, labor, prestige, or favorable situation, their competitors of foreign—and even of the same—nationality were compelled to look to improved methods of manufacture or production in order to hold their ground, and were thus brought to realize that educated labor and technical skill were the soundest elements with which to defend themselves in trade competition, in that they promote excellence of execution, inventiveness, enterprise, and all the qualities required to successfully conduct progressive industries. Under this pressure producers and manufacturers, through their guilds and other associations, were soon able to exert an influence upon their governments which has resulted in every European nation's making greater or less provision for public industrial education; until at this time not only England, France, Germany, Austria, Switzerland, Holland, and Italy, but all the minor Continental states, have their governmental schools for both elementary and higher technical instruction." Russia also has established Imperial Technical Institutes at St. Petersburg and Moscow, which are classed as among the finest in Europe, and the action of the Government has been supplemented by schools established by the leading railroads at their principal works. While the technical schools and departments in France are excellent of their kind, it is in Germany and Switzerland that the movement for industrial education has attained its highest development. In the latter country, the British Royal Commissioners found the value of its technical schools distinctly illustrated in the marked improvement of manufactures; in the elevation of the producing classes; in the diminution of crime; in the popularization of education; and, generally, exercising a most important influence upon the nation's industries and welfare. In summarizing the results of their investigations in Germany, they remark that the conviction is universal among the German people that they can only meet the competition of their rivals in other countries by training their workmen in taste and skill, and that the prosperity of their industries will increase only in proportion as they keep up the efficiency of their schools and spread their influence among the workers themselves.

The direct and indirect effects of technological schools upon the industries of their respective countries were, immediately upon their establishment, felt to be beneficial in the highest degree. Their graduates were eagerly sought out to fill important and responsible positions in manufacturing and commercial establishments, many of which had sustained serious losses through the ignorance and consequent bad management of administrative officers; and this inquiry soon far exceeded the supply. As the result of this appreciation of, and demand for, skilled laborers and supervisors, many enterprising corporations, and even private firms, engaged in manufacturing and other industries depend-

ent for their successful operation and development upon intelligent direction and skilled labor, individually organized scientific schools and training-classes in connection with their works. Some of these private schools are equal to or excel in particular features the government and municipal institutions. The conductors of many of them claim that the best results are obtained where intimate relationship between the school and the actual workshop is maintained; thereby facilitating the adaptation of theoretical training to the needs of the pupils and the character of the work on which they are engaged.

The leading merchants and manufacturers of Crefeld, Prussia, affirm that its silk industries largely depend for success on the influence of their technical school, which, among other things, raises the tone and increases the knowledge of rising manufacturers and foremen, and, by spreading technical education broadcast among industrious and ambitious artisans, very materially widens the field from which successful manufacturers and specialists may be chosen. At Mülhausen, Germany, manufacturers go so far as to say that their trade could not prosper without the influence of the textile museum; and citizens look upon the prosperity of the town as a result of what is learned at the technological institutions, whose action has exerted a marked influence in suppressing trade jealousies, which had almost entirely disappeared from the community. The chief hope of Verviers, Belgium, in maintaining pre-eminence in its textile industries, has been publicly acknowledged to rest upon the superiority and not on the cheapness of its productions. "This community has felt none of the evils of the late labor troubles in Belgium." The variety and excellence of the textile manufactures of Chemnitz, Saxony, are accredited by the British Royal Commissioners to the weaving-school; and the appreciation had by the citizens of the place for technical education is attested by the fact that, up to 1883, they had contributed over $440,000 for the support of their industrial schools. So, among the results that have accrued from the operation of the weaving and dyeing schools of Roubaix, France, are less need of supervision, economy in production, fewer mistakes, and more reliable and efficient work.

Of the same order with these facts is the acknowledgment said to be commonly made by the proprietors and managers of mines that young men who have been educated in technological schools heat their boilers better and with less coal than do the other workmen, and that their scientific knowledge enables them to escape many accidents and to avoid stoppage of machinery and repairs. In short, Dr. Barnard observes, "it is the testimony of all who have studied the subject that technical schools, when rightly directed, give wonderful impulses to industrial pursuits, by promoting scientific investigation and methods. Although at first this influence affects only those who attend the classes, it soon makes itself felt throughout the entire body of workmen of the community to which the school belongs, and the increased

interest in scientific subjects on the part of employés, thus developed, in turn reacts to the pecuniary advantage of their employers, because mechanics who have been trained in the scientific principles that underlie their handicrafts are thereby enabled to understand the technical publications affecting their trades, and to utilize new inventions and improved methods of work; while men uneducated in the rudiments of science ignore such sources of knowledge, and, quite naturally, oppose all improvements as innovations calculated to work injury to the laboring-classes. Cultivate a laboring-man's intelligence to a point where it recognizes improvements and comprehends their nature; his opposition ceases, and he will himself likely invent improved processes, which will inure to his employer's benefit. Technical education has been the means of attracting capital not only to specific localities, but to countries. Indisputable evidence of this is found in Switzerland, and notably in Zürich, where for years a technical school has been conducted at government expense. When, recently, the Federal Council was disposed to lessen the usual grant for its support, the manufacturers showed, by undeniable evidence, that this single institution had in a few years been the means of bringing capital to the country to the extent of millions of pounds sterling."

The British Royal Commissioners testify that a few years ago the question of technical education in England would have been a debatable one, but that now no argument is needed to convince English employers of its importance; that it has been tried, and has given the highest satisfaction; that in nearly all the great industrial centers schools of science and art, of various grades, together with numerous art and science classes, are to be found in successful operation, and that their influence may be traced in the improved productions of the localities in which they are placed; in the decreased consumption of crude material, and in saving of time required for the performance of labor. Through the agency of technical schools, wherever they have been established, originality has taken the place of servile imitation; decaying industries have been revived, and new ones promoted; while they have exerted a most marked influence in developing the intelligence and skill, and consequently in securing the permanent prosperity of the industrial classes generally, by enabling them to develop the sources of wealth peculiar to each country.

A noteworthy example of the collective advantages which technical education can confer is afforded by Switzerland, a country which is without navigable rivers, canals, mines, fertility, and the other natural gifts which are the usual foundation of the prosperity of civilized states, but where industrial education is highly developed. From it are yearly exported industrial products exceeding in value all the importations of the cantons, and also more than sufficient to cover the cost of internal administration.

If the results of an educational system can be ascertained from a

close inspection of those industries in which the mass of a country's population is engaged, and in which their knowledge is displayed by the fruits of their labor, it will be found that the national system of popular education in the United States fails entirely in accomplishing its mission, in several important particulars. For example, in the public schools our youth are, as a rule, entirely untaught in even the rudiments of industrial occupations, and upon passing from the school-room are generally utterly incompetent, unassisted, to earn a livelihood in any trade or pursuit requiring manual dexterity. Even our high-schools leave their graduates to drift, by accident or unintelligent direction, into vocations generally foreign to their abilities, and, as a rule, with few exceptions, unequipped with that character of knowledge or expertness without which a comfortable living becomes difficult—prominence impossible. It is commonly accepted as a fact that a good elementary education, such as is afforded by our public-school system, gives a child that which will carry it well along in life; but this is true only of agricultural, or at most of sparsely settled districts, and is then true only within limitations. The tendency of the system is—by elevating pupils above their actual or probable stations in life, and prompting in them desires and aspirations of which there is little chance of fruition—to turn out a large class of consumers, who fail utterly of success in the professions and kindred occupations, under conditions which, had their efforts been directed to mechanical or other industrial pursuits, would have made them efficient producers. A remarkably small percentage of our public-school graduates in the Middle and in the Southern States engage in any kind of manual labor.

Recognition of this lack of utility in our educational system has, of late years, become quite general, resulting in efforts to ingraft upon our higher-grade institutions industrial and scientific instruction, and the colleges and schools whose curricula embrace those subjects which fit our boys and girls to participate in the practical work of life are now rapidly increasing. There have long existed in the United States a certain number of educational institutions wherein special attention is given to technical and scientific training in mining, civil and mechanical engineering, applied mathematics, physics, and the natural sciences, which are fully equal to the best of similar schools in Europe. Among the most prominent of these are the School of Agriculture and Mechanical Arts of Cornell University, the School of Mines of Columbia College (New York), the Massachusetts Institute of Technology, the Lawrence School of Science in connection with Harvard University, the Pardee Schools, the Stevens Institute at Hoboken, the Rensselaer Polytechnic Institute, and the Sheffield School at Yale; but the high tuition fees charged by these and similar schools make instruction therein available only for the wealthier classes. Elementary science is also now taught in numerous colleges, academies, and high-schools. But, while this instruction, in point of cost and preliminary

educational qualifications, is generally within the reach of the masses, the subjects taught and, as a rule, the manner of teaching them, have but little practical bearing on industrial pursuits. However, in the last few years considerable progress has been made in introducing a substantial help to industrial education — that of manual training-schools—and already their feasibility and desirability as a feature of popular education have been practically demonstrated. Well-equipped schools of this character are to be found in St. Louis, Chicago, Toledo, Philadelphia, and Boston.

The secret of the popularity of this kind of education is to be found in the natural and practical combination it makes of intellectual and manual training. Both thought and action are developed equally, and the skill acquired at school, together with the respect for industrial pursuits there fostered, makes their pupils useful, wealth-producing citizens.

It is undeniable that our national prosperity has been greatly promoted by the pre-eminence of certain of our manufactures in the markets of the world; but our success in this respect has been due not to the superior intellectual cultivation or manual skill of our native artisans, but to very different causes, which we may regard as, in comparison, accidental; and it is sad to reflect what greater success might have been achieved by combining with these causes that high degree of intelligence and skill that European nations are cultivating in their industrial classes. While the value of our great workshops as practical technical schools may be admitted, the ordinary workshop does not yet combine mental instruction with manual training. At the same time, our science-teaching is of too high a grade to be assimilable by the ordinary mechanic and mechanical apprentice, and is too theoretical to be adaptable to the current work of the shops. There is too little application of science to our handicraft, and a lack of intelligent effort to teach apprentices in our workshops the mechanical dexterity which they are supposed to acquire there. Now that the old system of apprenticeship is becoming obsolete, the question of what shall take its place in the way of educating and training the youth of our working-classes becomes an important consideration.

Provision for teaching mechanic-trades was attempted in the organization of the agricultural colleges, but most of these institutions have drifted away from the original intention of the authors of the act, and there is in them, generally, little or no effort to combine theoretical instruction with practical mechanical training in other than those branches of knowledge closely related to agricultural pursuits; and much remains to be done before they can be of any material advantage to manufacturers and others requiring skilled labor. Our privately endowed schools do this work more directly and efficiently, but not as perfectly as they ought. Our university special departments, and our technological schools, even aggregated, are insignificant in

number, and in most of them instruction in the mechanical arts has not been strictly adhered to, having been obscured by the literary and art-science sides of education. That this tendency is a very grave danger in technological schools generally, is very apparent from a study of those in England, where most of the institutions established purely and simply for technical instruction are already drifting into devotion for the higher branches of the natural sciences and mathematics, to the exclusion of drawing, applied science, and mechanical teaching. Judge MacArthur says that while we have schools for all sorts of instruction in mathematics, history, literature, and philosophy in abundance, they fit nobody with either knowledge or skill in any particular branch of industry. There is even a tendency in them to beget dislike for those pursuits that require manual labor. Our national system of elementary education is also drifting to the literary side, and tending to beget a distaste for manual work and industrial pursuits in general. Among the defects charged against existing provisions for industrial training, are that the instruction is too expensive for work-people; that the conditions of admission are too advanced for the mass of the people; that the instruction in most of the schools is too theoretical; and that, for the lack of evening instruction, the masses of mechanics who are compelled to labor during the day are debarred from availing themselves of their advantages, such as they are.

A dark-shadowed picture is drawn of the condition of the trade and the manufacturing industries of Baltimore. The former has declined in an alarming degree, and the latter have never been developed to any notable extent. Facts are presented bearing on some of the particulars of these categories, and evidence is given from which the conclusion is deduced that the manufacturing arts of the community are languishing as much for the want of skilled and intelligent artisans and managers to direct their operations, as from the lack of capital, cheap raw material, or natural facilities for production.

Johns Hopkins University, from which much might have been expected, lacks departments for training in practical industries. "With an income of $225,000 a year," says Mr. William Mather, an English observer of our schools, "it would appear possible for a larger amount of work to be done by this university among the people of the city, without in any degree diminishing the high class of instruction in the advanced stages of literary and scientific study."

In no field is more room afforded for the application of such skill and knowledge as technical training gives, than in the management and operation of railroads. Railroading has, in fact, become a profession, fully as exacting and requiring as high degrees of professional skill and intellectual attainments as the liberal professions. Yet Dr. Barnard has failed to find that "any of our railway managers have a proper appreciation of the situation, or that there has been any well-digested effort in the direction of educating railway officials or em-

ployés upon systematic lines, such as, for example, produce at West Point and Annapolis corps of young men whose basic education and training, with a little experience, fit them for any position of responsibility and trust in our military and naval service. Unquestionably there must be in many of our large railway organizations those who have long recognized the need of, and would warmly welcome, this educational factor in railway management, and doubtless many of them are, from previous education and long experience, peculiarly qualified for making a forcible presentation of the advantages of—and in view of the great changes that scientific discoveries are making in methods of production and transportation, and the new industries that are continually springing up, I may say the absolute necessity for —a combination of scientific and technical education for the operatives of the transportation service of the country. But, unfortunately, men of this type are, as a rule with few exceptions, overtasked with responsibilities and harassed with anxieties that leave few opportunities and little inclination for expressing their views on any subject foreign to their specific duties."

In the same ratio that our extensive railway system surpasses all other branches of industry in the magnitude of its business, the number of its departments and the interests affected, is there greater need for economy of administration and greater necessity for the application of the highest obtainable scientific knowledge and manual skill to its various operations. It has become the almost universal practice of our great railway corporations, and especially those whose lines are reaching out into undeveloped and sparsely settled territory, to assume the entire repairs of their plant, even when they amount to practical reconstruction, and there is also a steady tendency on the part of such companies in the direction of manufacturing their own equipment from raw materials. This places them in the category of manufacturers, and makes them amenable to the laws and factors regulating production. Because of the nature of their service, involving the transportation and care of many lives and valuable property, no less than as a matter of economy, is it of prime importance to such corporations that, in the construction and in the repair of their rolling-stock and appliances, they should employ workmen of exceptional competency.

Railroad enterprise is a comparatively new thing in the world's history, and its development has been sudden. Men trained to carry on the work could not easily be obtained. They were picked up where they could be found; lacking scientific training, they were naturally guided by "rule-of-thumb" practice, and their lives were sure to be narrowed, till they acquired a pride in being known as "practical" men. These men naturally transmitted their narrowness of knowledge and skill to their apprentices; and thus has been developed the average railroad workman of to-day. Many of our railroads employ armies of people, all of whom are supposed to be technically expert in

their various vocations; but it is a well-known fact that in many railroads only one or two men in a road-gang know how to tamp a tie so that it will not require resetting the same season; and extensive lines are known to the author that do not possess a foreman—perhaps not a supervisor—who can adjust a curve with instruments. In these extensive enterprises the efficiency of the unit—the individual workman—becomes an item of grave economic consideration; for if it be true that the value of the individual's work (whatever it be) is increased through greater intelligence and special training, though it be only by a few cents per day, the total is of no inconsiderable moment, when his services continue through a series of years, and when, instead of one workman, thousands are employed. If even a slight deficiency in the skill and intelligence of one workman makes a few cents' or a few dollars' difference in the cost of the products of each week's labor; if the incompetency of one foreman or one manager lacking scientific training does usually—as so positively stated by competent authorities—net an appreciable loss; multiply the result to corporations like, for instance, our Eastern trunk-lines (one of which employs at least fifty thousand people on that part of its system east of the Ohio River, and more than half as many more west of it); realize that in such extensive organizations few if any of the practical details of the operating departments can be accurately gauged by those whose interests are most vitally concerned; comprehend how many important matters, involving grave consequences in their execution, must be intrusted to superintendents, master-mechanics, and foremen; then obtain a correct measure of their education and general knowledge (to say nothing of their scientific attainments), and we shall begin to appreciate the importance and bearing of this question of technological education, and the enormous losses the lack of it yearly entails upon investors in railway securities.

In railway service there is frequent necessity for sending to a distance, and beyond supervision, one or more thoroughly competent men, who shall not be simply mechanics, in the ordinary acceptation of the term, but who shall be able to turn their attention to work coming under their notice, whether they have before done that thing or not. At present such men are rarely found enrolled in the rank and file of railway mechanical departments; yet it is testified by many manufacturers who have afforded their operatives the advantages of technological instruction, that they have no difficulty in filling such positions with boys of twenty or twenty-one years of age, whom they send long distances and place in their hands work with which they have had little or no previous acquaintance, and by their intelligence they not only give the greatest satisfaction, but frequently develop into competent teachers of others.

The reason for the educational deficiencies of railway operatives is apparent when we consider how few opportunities they have for

acquiring theory and practice in the same place and at the same time. The chasm between our schools and our workshops is not bridged, and consequently manual skill and intelligence remain divorced. All our higher schools, and even our technological schools, turn out students who are well up in theory, but deficient in practice. It is at the same time difficult to procure at any price men who combine superior skill, comprehensive mechanical knowledge, and general intelligence in such proportions as to make them valuable as foremen, managers, and specialists in mechanical pursuits or in the operating branches of railway service. Graduates of technological schools, when introduced into these positions, are apt to continue to show themselves more theoretical than practical. This constitutes an objection to depending on men of this class. The Pennsylvania Railroad pursues the plan of exacting of the graduates of technological institutions entering its service a novitiate in the construction and repair shops at Altoona before they are permitted to enter active service. Many young graduates of technical schools so highly value the opportunity of studying the scientific methods and enjoying the instruction of the Altoona shops as—it is said—to disregard pecuniary compensation, in a wise desire to avail of the fine training obtainable there. At the same time, this instruction is believed to be neither so specific nor so thorough as it should be.

"Many of the discoveries of the day are not used because workmen do not understand them, or are incompetent or unwilling to utilize them, and there is also an acknowledged deficiency in the ability of railroad employés to determine, with scientific accuracy, the shapes and dimensions which are best adapted to stand the strains of the various working parts of the locomotives and other machinery used by railroad companies. Though much has been done in this direction by specialists, it is more than probable, from their testimony and from the deficiencies of such machinery, that scarcely a tithe of the facts that may and ought to be known in this matter are yet discovered, or, where known, availed of. Such investigations, owing to the scarcity of men combining both practical and theoretical knowledge, are so costly and uncertain, and require so much skill and technical training to conduct them, that manufacturing companies can not often afford to hire specialists or bear the expense of experimenting ; but in a school connected with railway-shops, under competent guidance and instructors of ability, much may be done, as a part of the school and shop-work instruction, that will, at the same time, accomplish desirable results in other fields. It is the testimony of many of our best educated engineers that the engineering profession in all its departments is continually hampered by the want of more extensive and more accurate experiments. They say that 'in far too many matters they have nothing to rely on but the imperfect or imperfectly reported results of antiquated experiments.' The difficulty is, that most of their

experiments and observations have necessarily to be of short duration, and that they have insufficient data upon which to base their conclusions. If, now, we can introduce the scientific method of original research and experiment into our workshops; if, instead of one experimenter, there may be dozens of wide-awake, observing, and energetic men in search of scientific and mechanical truth; if, instead of one experiment at a time, there may be several under different circumstances going on at the same time; if, instead of continuing a single day or a single week, these experiments in the workshop may be continued through months and even years; if, in other words, our workmen, or a large number of them, can be taught to regard the workshops themselves as great laboratories for continued research, experiment, and observation with a view to gaining original information for practical purposes—then there need be no more complaint in the realm of applied science about inadequate data and uncertain conclusions."

This system would also furnish a stimulus to invention and improvement and to the adaptation of economical devices. The importance of technical training is so well recognized among European manufacturers that many employers are said to be in the habit of sending to home and foreign exhibitions, at their own expense, those of their young people most advanced in technological study and of quickest perceptions, in order that they may study new inventions, machinery, etc.; while many others allow their apprentices and young men to leave their work an hour or more before stopping-time, on class-nights, without abatement of their wages. Many European manufacturers and the managers of some foreign railway-works now call the particular attention of their workmen to new designs, improvements in machinery, and methods of work, and to successful inventions that have been made by other workmen trained in technical schools. Such workmen can not fail to become constantly on the alert for opportunities to accomplish something above the performance of mere routine duty; whereas, lacking scientific knowledge and technical training, they would probably be contented to go on in the old paths of routine, and might even oppose improvement.

Among other advantages of technological schools adapted to the wants and standard of the workmen who are to attend them are, that they will do much to prevent and overcome labor troubles, which often arise through misunderstandings that the instruction given by such schools and their influence would anticipate; that their effect will be to diminish the tendency to dissipation among the workmen, and increase their efficiency; and that, by providing useful and congenial employment for the leisure time of apprentices, they will, promoting good habits and discouraging the formation of bad ones, have an especially beneficial effect upon their future. Workshop-schools have the further advantage over others that, giving easy access to machinery, and directly applying the principles and theory learned in

the school-room to work in the shops having a commercial value, they would make their instruction practical in a high degree. They are also especially valuable for training the young of our industrial classes, because the pupils are thereby enabled to earn a livelihood while acquiring theoretical and practical knowledge as they go, each supplementing and assisting the other.

Whatever the Baltimore and Ohio Railroad has achieved in the way of commercial success has not resulted from superior skill or intelligence of its subordinate officers or of the rank and file in its several departments, but rather in spite of their deficiencies. The company has been fortunate in one sense, in that the geographical isolation of its main stem and branches has contributed to the gradual formation of a corps of operatives who, by descent, tradition, and personal attachments, may be said to belong to the road. From their earliest youth they have looked forward to an active participation in the operations of the line as a means of livelihood, and all their aspirations and ambitions are associated with its service. This condition has been fostered by the custom of regarding the children of meritorious operatives as entitled to prior consideration in making appointments. While this has resulted in creating and maintaining a corps of operatives of exceptional devotion and loyalty, and has in many other ways been advantageous to the service, it has also in some ways that were unforeseen proved prejudicial to the company's interests. Thus, the inhabitants along the main-stem divisions are destitute of educational facilities, and this, coupled with the sense of proprietorship in the positions and the idea that education beyond the bounds of his trade is of no practical use to a mechanical workman, has created indifference on the subject. This was one of the considerations which prompted the establishment of the school at Mount Clare. Of the first class of boys examined for admission to the school, only forty were found in such a condition of discipline and grounding in the common English branches as to justify the hope that they could enter upon the course for graduation as mechanics, and not one of them was capable of entering upon the higher studies necessary to qualify him for an officer's position in the service. It being thus manifested that there was no material from which to manufacture efficient officers, nor was any likely to be acquired under the then existing system, a general order was issued promulgating regulations for the future admission of apprentices, and prescribing the minimum qualifications of candidates, which, while neither onerous nor of a high grade, provided a sufficient foundation for the technical instruction necessary to make a fairly educated mechanic. In the same general order the lines upon which the educational work was to be conducted were defined in general terms. The plan outlined in that order contemplated.

1. Instruction (in the apprentice class of such boys as could pass the examination therein indicated) of a character that will make them

skilled and intelligent mechanics. While this first-class course would naturally lead up to the second or cadet class, it should provide within itself all the elements of technical instruction necessary to complete a journeyman's education.

2. A second or cadet course, which should also be complete within itself, and should provide such technical instruction in all the departments of railway service as would fit its students for all subordinate positions of responsibility and trust in the service, corresponding to what is known in European schools as the foreman's course of study. This course, while involving more thorough and wider theoretical instruction than the apprentice course, should, to the greatest extent possible, be framed with reference to the practical mechanical operations of the shops and of the service generally.

3. A third or cadet officers' course, the object of which will be to give to those who graduate with honor from the second class (and who have therein shown themselves possessed of ability and educational qualifications above the average) further technical training, of a still higher and more comprehensive type, which, when combined with familiarity with the operations of the various departments of the service, will go far toward qualifying the students of that course for the highest positions in the company's gift. To this end, opportunity should be afforded the pupils of this course, in its last year, to actively participate in the production, care, repair, and improvement of railway plant and in the practical operations of the service. This could readily be done—and with advantage to the service also—by distributing these students among the several departments as assistants, at the same time maintaining their connection with the school for further educational purposes. This course is not yet in operation.

In the apprentice course, school-instruction should be made secondary to shop-work, while in the higher courses shop-work should always be secondary to mental training.

Although these provisions relate especially to instruction in Baltimore, the plan has been drafted in a more general sense, and contemplates the gradual extension of this educational movement over the entire system of the railroad. While Baltimore will always be the center of such a movement, no great difficulty is apprehended in extending the apprentice course, at least, over the entire road, by establishing night-schools for drawing, mathematics, and elementary science, or securing the introduction of the boys into such schools as are already in operation, and the modification of their curriculum in the manner indicated.

Prior to the establishment of school-work at Mount Clare, the Baltimore and Ohio apprentices had neither incentive nor opportunity to develop into intelligent workmen, so that on starting the classes it was with great difficulty and only by absolute compulsion that the attendance of about forty shop-boys was secured. They were, with few ex-

ceptions, rude and almost unmanageable in the class-room, uninterested in the instruction, and scarcely able to await the hour of dismissal, when they would vacate the school-room rudely and in haste. Then the class-instruction was confined to the most elementary subjects, and the boys were unable or unwilling to read technical or scientific books with any show of profit. Now there are under school-instruction seventy-five as orderly and polite boys as are to be found in any high-school of the country, and among the very best of them are boys who a few months ago were conspicuous for rudeness and insubordination. There have been classes of apprentices in geometry, algebra, physics, locomotive-engine, mechanics, mechanical drawing, free-hand drawing, geometrical drawing, English and history, and a valuable method of instruction by special reading, selected and recommended by the teachers to each pupil, with special reference to his talents and the state of his education.

Last year, as a rule, boys had to be compelled to take up algebra and geometry; at this time many are promising promptness, regularity, and other inducements to secure admission to those classes, and a number have become very urgent for the higher science and mechanical studies. Many of these boys regularly spend their noons studying works in science and mechanics, going from shop to shop and from machine to machine, studying the principles involved in their construction and operation. Every examination for apprentices brings in a better class of applicants; as the result of which the standard upon which admission to the service is predicated is being gradually raised.

It may be added that the practical result of this report has been to induce the Board of Directors of the Baltimore and Ohio Railroad Company to make a permanent appropriation of $20,000 annually for the conduct of this school, and that Dr. Barnard is now engaged in the preparation of plans for what will be the first technical railroad-school ever established in the United States.

GRAINS OF SAND.

By GEORGE WARDMAN.

THE manufacture of sand is an important industry, which has Pittsburg for its headquarters, although the sand is not made within the limits of the city. There is a considerable traffic in Monongahela sand, which is scooped up from the bed of the river, to be used for common building purposes; but the manufacture of sand is quite another affair, and the product goes into quite a different commodity, which is glass.

Practically glass is almost pure sand, other substances used in its

manufacture for fluxing being consumed while the sand is transformed to a greater or less degree of transparency. The sand used in glass-making is almost pure silica, so nearly pure that there is less than one per cent of iron, magnesia, and aluminum, to ninety-nine + per cent of the other. And of this sand, which is quarried out of the hills and ground down to varying degrees of fineness, and washed to varying degrees of whiteness, eight hundred tons are manufactured daily, four hundred tons being consumed in and about Pittsburg, and four hundred tons going into Eastern Ohio and West Virginia to Wheeling, Bellaire, Columbus, and all points within a circuit of one hundred and fifty miles from Pittsburg.

In selecting, a darkish sand is found, containing more foreign substances than the ninety-nine per cent silica, which inferior grade goes into green or "black" bottles, and a still darker and baser earth, which is used for sanding fire-brick molds; another and finer dark grade, which is used by crucible-steel manufacturers; and still another quality, the whitest and grittiest, which becomes "flint," or what might be called absolutely transparent glass. An inferior quality of white sand is used for prescription-bottles, but the very best is for the higher grade of flint-ware.

Looking through the flat surface of window-glass, whether plate or blown, it appears colorless; but, if the sight is directed through the edge, it will disclose a sea-green tinge. Flint-glass proper is not so. It is absolutely colorless, except when cut into faces or prisms, when it reveals the colors of the spectrum.

The cost of a ton of sand to glass-manufacturers of Western Pennsylvania, Eastern Ohio, or West Virginia, is, of course, dependent on the distance it is hauled from the quarry; but, taking the eight hundred tons daily manufactured and consumed, it will not average above $2.25 per ton, damp. Dried sand will average $2.50 per ton. Of course, it costs a little less than those figures in Pittsburg, and a little more in Bellaire, Ohio; but even at this last-named place, the cost of the sand which goes into the manufacture of a box of common window-glass, containing the regulation fifty square feet of surface, is about five cents; that is, the box of glass consists merely of five cents' worth of silica, transmuted to a state of transparency.

The sand used in the glass industry in Western Pennsylvania, Eastern Ohio, and West Virginia, comes from three quarries: one on the Pennsylvania Railroad, overlooking the Juniata; one on the Baltimore and Ohio Railroad, near Connellsville; and one on the Pittsburg, McKeesport, and Youghiogheny Railway, twenty-five miles south of Pittsburg. It is quarried out like building-stone, passed through a quartz-crusher, further reduced under immense iron wheels, and finally ground and washed in an endless screw. The washing releases some of the foreign substances, but streaks of iron which are sometimes found running through the stone are knocked off to undergo the

milling process for the inferior quality of sand, some of which goes into mortar for specially fine and durable wall-building. The railroads use large quantities of it in the construction of retaining-walls for embankments. And so all grades of the sand are utilized.

APPEARANCE AND REALITY IN PICTURES.

By Dr. EUGEN DREHER.

IN the contemplation of the creations of the painter, the mind is stimulated to a degree of activity which the enjoyment of no other form of art-work can induce. A mental operation is provoked of which we are hardly conscious, and which some have attributed to the organization of the visual apparatus, that amounts in effect to the transformation of the flat surfaces of the picture into the appearance of a body or a group standing out or receding in relief. The inquiry as to how the painter can invoke this illusion is usually answered by saying that he knows how to represent objects in perspective; that is, that he is able to arrange the lines of the picture—except that the image is not reversed—so that the adjustment shall correspond essentially with that of the image which is cast upon the photographer's screen or upon the retina of the eye. The process, unperceived and instantaneous in the case of simple objects, by which such representations are given bodily projection, may be followed out in its gradual development in contemplating pictures of a more complex character, as, for instance, a view of the interior of a grand cathedral. Without any change taking place in the image on the retina, the individual objects are gradually lifted one from another; those represented as in the background appear to become larger but at the same time obscure, and those in the foreground to grow smaller but more sharply defined. Thus the size we attribute to the objects depends upon the distance we assign to them as well as on the visual angle they subtend. There are, according to this, unconscious processes that fit us for seeing plane surfaces as bodies, provided the picture furnishes suitable points to which our conceptions of corporeal projection may attach themselves. To see a perspective representation of a cube, I must have remaining within me a conception of a cube already acquired by the exercise of my senses; and, without such an acquired conception, the picture would still be to me only a picture or a planimetric feature, without projection. Hence we find that, in looking at pictures, unconscious representations intrude upon the primary conceptions, and change them into secondary ones, by means of which a surface is made to look like a body having projection. This process occurs in all monocular vision, when we interpret the flat retinal image corporeally.

To obtain a proper appreciation of a perspectively correct picture,

we must look at it with one eye; for, in looking with two eyes, the duplication of the visual lines that define the position of each point as it is perceived, must cause more or less of the impression of the really plain surface to persist. In this case the corporeal projection becomes confused with the superficial conception, and is more or less modified by it. The effect of perspective is also heightened by looking at the painting through a tube, by means of which it is abstracted from the frame and from its surroundings.

We observe, also, in looking at a picture, the curious phenomenon that, whatever position we may take toward it, it always appears projected, but in aspects which are varied not only in respect to the absolute position of its constituent parts, but also in respect to their mutual relations with one another, to such an extent that from an extremely unfavorable position it appears distorted.

Whenever an artist can not produce the perspective effects he desires in a picture drawn with absolute correctness, he does not hesitate to exaggerate the perspective if he thinks he can thereby enforce a better conception of his design. He represents distant objects on a smaller scale than strict accuracy demands, and causes us, by unconsciously taking account of the reduction, to see them farther off than we otherwise would do; and he knows how to call our imagination to his help in other ways.

Although the application of perspective devices is usually enough for the purpose, the projection of the design is heightened to a considerable degree, facilitated and brought nearer the appearance of reality by the introduction of effects of light and shade. This also is borrowed from Nature. The shading may, indeed, sometimes define and fix the effect which mere perception fails to convey positively. A square with two diagonals drawn across it may mean simply that, or it may be intended to represent a pyramid. If proper shading is added, the figure is made to mean a pyramid unmistakably.

If we assume that the light is evenly diffused through any space, then, other conditions being equal, those things in the space which are nearer to us will be clearer in appearance in a proportion determined by the rule that the intensity of light diminishes as the square of the distance increases. A point twice as far from the eye as another appears four times as obscure. This normal diminution of intensity is augmented by the darkening which objects undergo in consequence of the interposition of strata of air, or by the effect of "air-perspective," as it is called, in distinction from linear perspective. The painter must take both of these phenomena into account. By the application of a suitable coloring, the effect of air-perspective may be produced in so striking a degree that objects may, by means of it, be made to appear wonderfully remote. This effect, also, is dependent upon our unconscious application of knowledge we have gained from previous experience.

The shadow which all objects cast when exposed to any kind of light is a capital sign of bodily substance. Our conception of bodies is inseparable from that of their shadows. The importance of this phenomenon as an aid to projection is illustrated by the manner in which through them flat letters on signs are made to appear standing out as solid bodies.

The painter is also able to represent motion by taking advantage of the unconscious working of our preconceived impressions. Looking at a masterly marine landscape in the National Gallery at Berlin one day, I could almost see the ship rising and falling upon the waves, and the waves themselves seemed to be in motion as they swelled and swept by the vessel. The painter had seized a single instant in the succession, and had so represented it as to call out the idea of consecutiveness. The question arises, How is the artist to illustrate motion, as he often has to do, say in such a case as that of a rapidly turning wheel, in which we can at no instant distinguish the single spokes, but see only a confusion of flying lines? It is clearly impossible for him to give the exact appearance of motion. He can only seize a given instant or stage, and so manage that it shall represent itself as the effect of the preceding stage and the cause of the following one: A sword-blow must be represented at a decisive point, not at a stage in the descent of the weapon, else the illusion will be destroyed; a pendulum in motion, not at the bottom of its course, where it would seem to be at rest. In painting a galloping horse, no stage of the exact motion is reproduced. The instantaneous photographs have demonstrated that; and also that, if the artist should attempt a reproduction of the kind, he would give any but the effect desired. He makes a more pleasing and probable picture, having, however, no counterpart in Nature, in which he does no violence to her, but, as Schiller has said, "increases the nature that is in Nature."

The theory of color-perceptions is not yet far enough advanced to permit a full explanation of all the phenomena of coloring; still, it is competent in its present condition to give valuable hints concerning the color-effects experienced in the contemplation of paintings.

All the variations in color perceived in Nature may be produced from red, yellow, and blue, or, as others have it, from red, green, and violet, and their combinations. The painter does not possess any of these colors in their purity, but always adulterated with more or less that is foreign to them, and can hardly ever reproduce the exact color he finds in Nature, and it is his task to combine the materials he has so as to give as near as possible an approach to them. How does he, with the deviations he is forced to make, bring about the magic illusion that causes us to perceive in his creations the same endless play of light and color that Nature so lavishly bestows upon her pictures? How does he reproduce the burning glow of the setting sun and the objects it illuminates? He does it by means of a contrast of colors,

in which particular shades are given a changed appearance to our perceptions by backing them one against another. When, for instance, a tolerably clear red and a tolerably pure green are put together, both colors appear to undergo a change, and to gain in purity; or, in popular language, the red seems to become redder and the green greener. This proceeds from two causes, one of which is purely mental, and consists in the heightening of the contrast between the two colors when they are brought into comparison with each other; while the other is physical, and depends upon a kind of fatigue which the nervous fibers suffer in consequence of the higher activity which the presentation of the contrast develops in them. As the perception of the red becomes wearied, that of the green becomes more acute, and *vice versa*, and the two in this manner react upon each other. By a similar process, white reposing upon black appears clearer and purer, while the black seems deeper and darker.

A painter, having to introduce two kinds of light, daylight and candle-light, into his picture, would not be able to represent directly the contrasts which the struggle between the two kinds of light calls forth in Nature, because his colors are so inferior in intensity to the reality. He has to paint the effect in by making the daylight relatively bluer and the candle-light more of a red-yellow than in Nature. He thereby leads us, after an interval, to an illusion of the same character with that which Nature, by the superior intensity of its light, produces in a moment.

In like manner, the painter, by exaggerating the illumination of his objects, reproduces similar effects to those which Nature gives with the full brilliancy of its light; as, for instance, the glow of the snow-fields of the Alps, which the beams of the evening sun clothe as with a garment of fire, in contrast with the dark-blue vault of the sky above them, and with the valleys already hiding themselves in the shadows of night. In all these cases the action of Nature is made more speedy than that of the picture, because the light at its disposal is so much stronger, but the effect of both is in the end of the same character, and the seeming becomes clothed with reality.

The painter must, furthermore, give effect to other color-perceptions which are wholly conditioned upon the organization of the eye. These are the subjective conceptions that show forth the complementary colors. By this term are meant those colors which in combination produce white, as red and green, blue and orange, yellow and violet. The complementary tint also appears after the eye has become fatigued in looking at a particular color, as when the eye has been gazing at green, it turns to a white spot and appears to see it red.

The complementary effects may frequently be observed in Nature. Parts of the sky between bright-red clouds sometimes appear green; and the ground of a wood, the bright-green foliage of which glitters in the sunlight, looks rose-colored. The painter has to take these

phenomena into consideration, and, making due allowance for the weakness of his pigments, to incorporate the apparent tints into his picture. Here, again, what Nature with her vivid colors does in an instant, the artist has to bring about more slowly ; but the illusion is complete in both cases from the moment our conceptions are brought into accord with it.

There is, furthermore, something in the colors of natural objects which is distinct from the strength and clearness of the illumination, and appears peculiar to certain kinds of light. Among such peculiarities are the metallic luster, the silken sheen, and opalescence, which, although they all proceed from combinations of the spectrum-colors, have not yet been sufficiently investigated to enable us to determine all the circumstances contributing to produce them.

The colors used in painting afford little that is analogous with these lusters. Can the painter produce these effects also by contrast ? They appear in pictures by the most eminent masters to be reached almost in perfection. If, however, we inquire whether the painter can reproduce the peculiarities of luster and color which we admire so much in Nature through the contrast of his colors alone, we shall have to admit that he calls other elements into play.

We have already shown how our conceptions of the relations of objects in place are influenced by our unconscious prepossessions. May not these also intrude themselves upon and modify our conceptions of the color and tone of the picture ? The connoisseur who has frequently observed the shimmer of the sea, and who has followed with a finely developed perceptive power the transformations of the landscape under a changing light, and who has been in the habit of watching in an æsthetic mood the combination and grouping of the individual features of Nature, is doubtless better able to realize these peculiarities also in works of painting, than he who applies only a sharp but untrained discernment to the gradual development of the idea of the picture.

Thus art, temporarily withdrawing us from Nature by substituting her own creations for the reality, brings us back to Nature as the inexhaustible source whence all its elements are borrowed ; and the imagination, also, in its own way, is able to make use of those elements for new creations.—*Translated for the Popular Science Monthly from Die Natur.*

Colonel Serpa Pinto and Lieutenant Cardozo last year made a successful scientific exploration of the lake-region of Africa. They made a geodetic triangulation of the country from Ibo to Lake Nyassa, whence Lieutenant Cardozo—Colonel Pinto having withdrawn on account of illness—went to Shirva and Blantyre, and by a new road to Quilimane. This is the first scientific work of the kind done in that part of Africa.

AMONG THE TRANSYLVANIAN SAXONS.

BIRTH AND DEATH.

[*Concluded.*]

BY-AND-BY, when a few months have passed over the head of the new-married couple, and the young matron becomes aware that the prophecies pointed at by the doll's cradle and the broken distaff are likely to come true, she is carefully instructed as to the conduct she must observe in order to insure the well-being of herself and her child.

In the first place, she must on no account conceal her state, or deny it when interrogated on the subject—for if she do so, her child will never learn to speak; nor may she wear beads on her neck, for that would cause the infant to be strangled at its birth. Carrying peas or beans in her apron will produce malignant eruptions; and sweeping a chimney will make the child narrow-breasted.

On no account should she be allowed to pull off her husband's boots, nor to hand him a glowing coal to light his pipe; for both these actions bring misfortune. In driving to market she may not sit with her back to the horses, nor may she ever drink at the well out of a wooden bucket.

Also, her intercourse with the pig-sty must be very carefully regulated; for if she listen too attentively to the grunting of pigs, her child will have a deep, grunting voice; and if she kick the swine or push them away with her foot, the infant will have bristly hair on its back. Hair on the face will be the result of beating a dog or cat, and twins will be the consequence of eating double cherries or sitting at the corner of the table.

During this time she may not stand godmother to any other child, or else she will lose her own baby, which will equally be sure to die if she walk round a newly made grave.

If any one throw a flower suddenly at the woman who expects to become a mother, and hits her with it on the face, her child will have a mole at the same place touched by the flower.

Should the young matron imprudently have neglected one of these rules, and have cause to fear that an evil spell has been cast on her child, she has, however, several very efficacious recipes for undoing the harm. Thus, if she sit on the door-step with the feet resting on a broom for five minutes at a time on seven consecutive Fridays, thinking the while of her unborn babe, it will be released from the impending doom; or else let her sit there on Sundays, when the bells are ringing, with her hair hanging unplaited down her back; or else climb up the belfry-tower and look down at sunset on to the landscape below.

When the moment of the birth is approaching, the windows must

be carefully hung over with sheets and cloths to prevent witches from entering; but all locks and bolts should, on the contrary, be opened, else the event will be retarded.

If the new-born infant be weakly, it is usual to put yolks of eggs, a glass of old wine, bran, or sawdust into its first bath.

Very important for the future luck and prosperity of the infant is the day of the week and month on which it happens to have been born.

Sunday is of course the luckiest day, and twelve o'clock at noon, when the bells are ringing, the most favorable hour for entering upon life. If a Sunday's child have its fingers rubbed with oil on every seventh birthday (7th, 14th, 21st, etc.), it will henceforward be able to perceive underground treasures through its transparent finger-tips.

Wednesday children are *Schlabberkinder*—that is, chatterboxes; Friday bairns are unfortunate; but in some districts Saturday is yet more unfortunate, while in other places they are merely supposed to grow up dirty.

Whoever is born on a stormy night will die of a violent death.

The full moon or growing moon is favorable, but the decreasing moon will produce weakly and unhealthy babes.

All children born between Easter and Pentecost are more or less lucky, unless they happen to have come on one of the distinctly unlucky days, of which I here quote the most important. These unlucky days are:

January 1st, 2d, 6th, 11th, 17th, and 18th.
February 8th, 14th, and 17th.
March 1st, 3d, 13th, and 15th.
April 1st, 3d, 15th, 17th, and 18th.
May 8th, 10th, 17th, and 30th.
June 1st and 17th.
July 1st, 5th, 6th, and 14th.
August 1st, 3d, 17th, and 18th.
September 2d, 15th, 18th, and 30th.
October 15th and 17th.
November 1st, 7th, and 11th.
December 1st, 6th, 11th, and 15th.

I leave it to more penetrating spirits to decide whether these seemingly capricious figures be regulated on some hidden system, the mystic workings of which have baffled my understanding; so that I am utterly at a loss to explain why January and April have the greatest number of unlucky days assigned to them, while June and October have the smallest proportion; and why the 1st and 17th are hardly ever harmless, while all days between the 18th and 30th are invariably good.

Both mother and child must be carefully watched over during the first few days after the birth, and all evil influences averted. The visit of another woman who has herself a babe at the breast, may deprive

the young mother of her milk ; and any one who enters the house without sitting down will assuredly carry off the infant's sleep.

If the child be subject to frequent and apparently groundless fits of crying, that is a sure sign that it has been bewitched, either by some one whose eyebrows are grown together, and may consequently be supposed to have the evil-eye, or by one of the invisible evil spirits whose power is great before the child has been taken to church ; but even a person with quite commonplace eyebrows may convey evil by unduly praising the child's good looks, unless the mother remembers to spit on the ground as soon as the words are spoken.

I will here quote a few specimens of the various recipes in vogue for undoing such evil spells :

Nine straws, which must be counted backward from nine till one, should be placed in a jug of water, drawn from the river with the current, not against ; into this are thrown parings of wood from off the cradle, the door-step, and the four corners of the room in which the child was born, also nine pinches of ashes, likewise counted backward. When all these various ingredients have been boiled up together, the water is poured boiling hot into a large basin, and the pot left in it upside-down. If the boiling water draws itself into the jug (as of course it will), that is proof positive that the child was bewitched ; and the mother should moisten its forehead with the water before it is cold, and give it (still counting backward) nine drops to drink.

The child that has been bewitched may likewise be held above a red-hot plowshare, on which a glass of wine has been poured ; or else a glass of water, in which a red-hot horseshoe has been placed, given to drink.

In almost every village there used, not long ago, to be old women who made a regular trade out of preparing the water which was to undo evil spells.

The Saxon mother is careful not to leave her child alone until it has been baptized, for fear of the malignant spirits, who may steal it away, leaving an uncouth elf in its place. Whenever a child grows up clumsy and heavy, with large head, wide mouth, stump nose, and crooked legs, the gossips are ready to swear that it has been changed in the cradle, more especially if it prove awkward and slow in learning to speak. To guard against such an accident, it is recommended to mothers obliged to leave their infants alone, to place beneath the pillow either a prayer-book, a broom, a loaf of bread, or a knife stuck point upward.

Very cruel remedies have sometimes been resorted to in order to force the evil spirits to restore the child they have stolen, and take back their own changeling. For instance, the unfortunate little creature, suspected of being an elf, was placed astride upon a hedge and beaten with a thorny branch until it was quite bloody ; it was then supposed that the evil spirits brought back the stolen child.

The infant should not be suffered to look at itself in the glass till

after the baptism, nor should it be held near an open window. A very efficacious preservative against all sorts of evil spells is to hang round the child's neck a little triangular bag stuffed with grains of incense, wormwood, and various aromatic herbs, and with an adder's head embroidered outside; a gold coin sowed into the cap will likewise keep the spirits away.

Two godfathers and two godmothers are generally appointed at Saxon peasant christenings, and it is customary that one couple should be old and the other young; but in no case should a husband and wife figure as god-parents at the same baptism, but each one of the quartet must belong to a different family. This is the general custom; but in some districts the rule demands two godfathers and one godmother for a boy—two godmothers and one godfather for a girl.

If the parents have lost other children before, then the infant should not be carried out by the door in going to church, but handed out by the window, and brought back in the same way. It should be carried by the broadest street, never by narrow lanes, else it will learn thieving.

The god-parents must not look round on their way to church; and the first person met by the christening procession will decide the sex of the next child to be born—a boy, if it be a man.

If two children are baptized out of the same water, one of them will soon die; and if several boys are christened successively in the same church, there will be war in the land as soon as they are grown up. Many girls denote fruitful vintages for the country when they have attained a marriageable age.

If the child sleeps during the baptismal ceremony, then it will be pious and good-tempered; but if it cries, it will be bad-tempered or unlucky; therefore, the first question asked by the parents on the return from church is generally, "Was it a quiet baptism?" and if such has not been the case, the sponsors are apt to conceal the truth.

In some places the christening procession returning to the house of the parents finds the door closed. After knocking for some time in vain, a voice from within summons the godfather to name seven bald men out of the parish. When this has been answered, a further question is asked as to the gospel read in church; and only on receiving the answer, "Let the little children come to me," is the door flung open, saying: "Come in; you have hearkened attentively to the words of the Lord." The god-parents next inquiring, "Where shall we put the child?" receive the following answer:

"On the bunker let it be,
That it may jump like a flea;
Put it next upon the hearth,
Heavy gold it will be worth;
On the floor then let it sleep,
That it once may help to sweep;
On the table in a dish,
It will grow then like a fish."

After holding it successively on each of these places, it is finally put back into the cradle, while the guests prepare to enjoy the *Tauf Schmaus*, or christening banquet.

Each person is expected to bring a small contribution in the shape of eggs, bacon, fruit, or cakes; and the god-parents do not fail to come each laden with a bottle of good wine, besides some other small gift for the child.

The banquet is a noisy and merry one, and many are the games and jokes practiced on these occasions. One of these, called the *Bad-springen* (jumping the bath), consists in putting a lighted candle on a washing-trough, which is placed upside-down on the ground. All the young women present are invited to jump over without upsetting or putting out the light. Those who are successful in this evolution will be mothers of healthy boys. If they are bashful, and refuse to jump, or should they be awkward enough to upset the candle, they will be childless, or have only girls.

The *Spiesstanz*, or spit-dance, is also usual on these occasions. Two roasting-spits are laid on the ground crosswise, as in the sword-dance and the movements executed much in the same manner.

Sometimes it is the grandfather of the new-born infant who opens the performance, proud of displaying his agility as he sings:

"Purple plum so sweet,
See my nimble feet;
How I jump and slide,
How I hop and glide;
See how well I dance,
See how well I prance.
Purple plum so sweet,
See my nimble feet."

But if the grandfather be old and feeble, and if the godfathers can not be induced to exert themselves, then it is usually the midwife who, for a small consideration, undertakes the dancing.

It is hardly ever customary for the young mother to be seated at the table along with the guests; and even if she be well and hearty enough to have baked the cakes and milked the cows on that same day, etiquette demands that she should play the interesting invalid and lie in bed till the feasting be over.

For full four weeks after the birth of her child must she stay at home, and durst not step over the threshold of her court-yard, even though she has resumed all her daily occupations within the first week of her recovery. "I may not go outside till my time is out; the *Herr Vater* would be sorely angered if he saw me," is the answer I have often heard from a woman who declined to come out on to the road. Neither may she spin during these four weeks, lest her child should suffer from dizziness.

When the time of this enforced retirement has elapsed, the young

mother repairs to church along with her infant to be blessed by the pastor; but before so doing she is careful to seek the nearest well and throw down a piece of bread into its depths, probably as an offering to the *Brunnenfrau* supposed to reside in each water, and who is said to lure little children down to her.

With these first four weeks the greatest perils of infancy are considered to be at an end; but no careful mother will fail to observe the many little customs and regulations which alone will insure the further health and well-being of her child.

Thus she will always remember that the baby may only be washed between sunrise and sunset, and that the bathing-water may not be poured out into the yard at a place where any one can step over it, which would entail sickness or death, or at the very least deprive the child of its sleep.

Two children which can not yet speak must not be allowed to kiss each other, or neither of them will ever learn to talk.

A book laid under the child's pillow will make it an apt scholar; and the water in which a young puppy has been washed, if used for the infant's bath, will cure it of all skin-diseases.

Whoever steps over a child as it lies on the ground will cause it to die within a month. Other prognostics of death are to rock an empty cradle, to make the child dance in its bath, or to measure it with a yard-measure before it can walk.

Death, to the Saxon peasants, appears in the light of a treacherous enemy, who must be met with open resistance, and may be conquered by courageous opposition or conciliated with a bribe. "He has put off death again with a slice of bread," is said of a man who has unexpectedly survived some great danger.

When the first signs of an approaching illness declare themselves in a man, all his friends are strenuous in advising him to hold out against it, not to let himself go, but to grapple with this foe which has seized him unawares. Even though all the symptoms of typhus fever be already upon him, though his head be burning like fire, and his limbs heavy as lead, he is yet exhorted to bear up against it, and on no account to let himself lie down, for that would be a concession to the enemy.

In this way many a man goes about with death upon his face, determined not to give in, till he drops at last senseless in the field or yard where he has been working till the last moment.

Even then his family are not disposed to let him rest. With well-meaning but mistaken kindness, they endeavor to rouse him by shouting in his ear. He must be made to wake up and walk about, or it will be all over with him; and not for the world would they send for a doctor, who can only be regarded as an omen of approaching death.

Some old woman versed in magic formulas, and learned in the de-

coction of herbs and potions, is hastily summoned to the bedside; and the unfortunate man would probably be left to perish without intelligent advice, unless the pastor, hearing of his illness, takes it upon himself to send for the nearest physician.

By the time the doctor has arrived, the illness has made rapid strides, and most likely the assistance comes too late. The first care of the doctor on entering the room will be to remove the warm fur cap and the heavy blankets, which are well-nigh stifling the patient, and order him to be undressed and comfortably laid in his bed. He prescribes cooling compresses, and a medicine to be taken at regular intervals, but shakes his head and gives little hope of recovery.

Already this death is regarded as a settled thing in the village, for many of the gossips now remember to have heard the owl shriek in the passing nights, or there has been an unusual howling of dogs just about midnight. Others call to mind how over-merry the old man had been four weeks ago, when his youngest grandchild was christened, and that is ever a sign of approaching death. "And only a week ago," says another village authority, "when we buried old mother Barbara, there was an amazing power of dust round the grave, and the *Herr Vater* sneezed twice during his sermon; and that, as every one knows, infallibly means another funeral before long. Mark my words, ere eight days have passed he will be lying under the nettles."

The village carpenter, who has long been out of work, now hangs about the street in hopes of a job. "How is the old man?" he anxiously inquires of a neighbor.

"The pastor has just gone in to knock off the old sinner's irons," is the irreverent answer.

"Then I may hope to be called in soon for making his coat (coffin). High time I was able to turn an honest penny again. I have a heap of damaged boards which were refused by the railway engineers still lying on my hands."

Sometimes, however, it is the thrifty peasant himself who, knowing the ways of village carpenters, and foreseeing this inevitable contingency, has taken care to provide himself with a well-made, solid coffin years before there was any probability of its coming into use. He has himself chosen out the boards, tested their soundness, and driven a hard bargain for his purchase, laying himself down in the coffin to assure himself of the length being sufficient. For many years this useless piece of furniture has been standing in the loft, covered with dust and cobwebs and serving perhaps as a receptacle for old iron or discarded shoes; and now it is the dying man himself who, during a passing interval of consciousness, directs that his coffin should be brought down and cleaned out, his glassy eye recovering a passing brightness as he congratulates himself on his wise forethought.

Death is indeed approaching with rapid strides. Only two spoonfuls of the medicine prescribed has the patient swallowed. "Take it

away," he says, when he realizes his situation—"take it away, and keep it carefully for the next person who falls ill. It is a pity to waste it on me, for I feel that my time has come, and nothing can do me any more good. Send for the preacher, that I may make my peace with God."

The last dispositions as to house and property have been made in the presence of the pastor or preacher. The house and yard are to belong to the youngest son, as is the general custom among the Saxons. The elder son and the daughter are to be otherwise provided for. The small back-room belongs to the widow, as jointure for the rest of her life; likewise a certain proportion of grain and fruit is assured to her. The exact spot of the grave is indicated, and two ducats are to be given to the *Herr Vater* if he will undertake to preach a handsome funeral oration.

When it becomes evident that the last death-struggle is approaching, the mattress is withdrawn from under the dying man, for, as every one knows, he will expire more gently if lying on straw.

Scarcely has the breath left his body than all the last clothes he has worn are taken off and given to a gypsy. The corpse is washed and shaved, and dressed in bridal attire—the self-same clothes which forty years previously he had donned on his wedding morning, and which ever since have been lying carefully folded by, and strewed with sprigs of lavender, in the large *Truhe* (bunker), waiting for the day when their turn must come round again.

A snowy sheet spread over a layer of wood-shavings is the resting-place of the body when it is laid in the coffin; for the head, a little pillow stuffed with dried flowers and aromatic herbs, which in most houses are kept ready prepared for this contingency.

An hour before the funeral, the bell begins to toll the *Seelenpuls* (soul's pulse), as it is called; but the sexton is careful to pause in the ringing when the clock is about to strike, for "if the hour should strike into the bell," another death will be the consequence.

Standing before the open grave, the mourners give vent to their grief, which, even when true and heart-felt, is often expressed with such quaint realism as to provoke a smile.

"My dearest husband," wails the disconsolate widow, "why hast thou gone away? I had need of thee to look after the farm, and there was plenty room for thee at our fireside. My God, is it right of thee thus to take my support away? On whom shall I now lean?"

The children near the dead mother: "Mother, mother, who will care for us now? Shall we live within strange doors?"

A mother bewailing her only son: "O God, thou hast had no pity. Even the emperor did not take my son to be a soldier. Thou art less merciful than the emperor!"

Another mother weeping over two dead children exclaims: "What

a misfortune is mine, O God! If I had lost two young foals, at least their hides would have been left to me."

And the children, standing by the open grave of their father, cry out: "O father, we shall never forget thee! Take our thanks for all the benefits received during thy lifetime, as well as for the earthly goods thou hast left behind."—*Blackwood's Magazine.*

SKETCH OF JULES JAMIN.

M. JULES JAMIN was a man of many talents. He held a high position in the scientific circles of his time, and was equally eminent as a teacher and lecturer; he was also well known in literature; and he achieved respectable success in some of the fine arts. He was able to acquit himself creditably in all this variety in occupations, without sacrificing the excellence of his scientific work; and it is on the last that his fame is founded.

JULES CÉLESTIN JAMIN was born at Termes in the Ardennes, August 30, 1818, and died in Paris, February 12, 1886. His father had served in the volunteers of the French Revolution, had gained the rank of captain, and had been decorated at the battle of Friedland. The boy was taught in the village school of Vouziers, and afterward in the college at Rheims, where he gained nine prizes in the first year, and received in 1838 the prize of honor in the competition between the colleges of Paris and the departments. In the same year he entered the Superior Normal School, and in 1841 received the first prize in the examinations of physics. From this institution he went to the college at Caen as a teacher of Physics; afterward to the Collége Bourbon (now Lycée Condorcet), and in 1844 to the Collége Louis-le-Grand. In 1847 he received the doctorate of Physical Science for a thesis on the reflection of light by the surface of metals.

The precision, elegance, and solidity of his instruction, say Jamin's foreign biographers, and the value of his scientific work, designated him for some superior professorship. So, in 1852, he was elected Professor of Physics at the Polytechnic School, where he lectured with success till 1881. In 1863 he obtained the chair of Physics in the Faculty of Sciences, where, by the extreme lucidity of his demonstrations, he achieved a great success. When M. Duruy, the Minister of Instruction at the time, founded the public lectures of the Sorbonne, he committed the inauguration of the course to M. Jamin; and the opening was, according to M. Jurien de la Gravière's eulogy in the Academy of Sciences, an event which "aroused the enthusiasm of the multitude." Here Jamin attracted a great number of eager listeners, and displayed, says "Nature," his admirable talent of exposition, as well as his great power of simplifying the most difficult questions,

and of indicating by most striking apparatus the methods of solving many intricate problems. The qualities that Jamin displayed in his oral teaching are found in his "Traité Général de Physique," which reproduces his course at the Polytechnic School, and "in which masters as well as pupils find exact descriptions of the actual state of science." This work was published 1858 to 1861, in three volumes.

M. Jamin was elected to the Section of Physics in the Academy of Sciences in 1868. In 1884 he was chosen perpetual secretary in the place of Dumas. His address on the anniversary of the admission of M. Dumas to the Academy was regarded as a rare example of pathetic eloquence; and in 1885 he delivered an address on the occasion of the centenary of M. Arago, which was characterized by its philosophical examination of the labors of that distinguished experimenter, and its thoughtful analysis of his mental powers, as well as by the clearness with which these points were presented.

M. Jamin's labors were carried on in very diverse branches of physics; and he interested himself and became versed in other departments of science and art. While studying for the degree in Physics at the Normal School, he also qualified himself for a degree in Natural Sciences. At Caen he took geological and botanical excursions with his pupils on Sundays. Of his regular studies he was first occupied with optics. His first memoir, already spoken of, on the reflection of light from metallic surfaces, was in this line, and was one of the best studies of the kind. Others were his studies of interferences, and of the measurement of the indices of refraction, of gases, of water under different pressures, and of the vapor of water. He discovered the elliptical polarization of light reflected by vitreous substances near the polarizing angle, and the negative elliptical polarization of fluorine; he published a memoir on colored rings, and invented interference apparatus in which the light reflected on opposed faces of thick transparent rings was utilized. He made discoveries in capillarity. In 1873 he exhibited a foliated magnet which was capable of carrying twenty-two times its own weight, while the greatest carrying power attained by artificial magnets previous to that time had been from four to five times their weight. This result was obtained by substituting, for the thick plate hitherto employed, a sufficient number of very thin plates superposed on each other, and all thoroughly magnetized. In these and other experiments in electrical science M. Jamin was greatly assisted by the research laboratory which M. Duruy had endowed. Among the later fruits of these researches was the perfection of the Jamin electric light, as an improvement upon the Jablochkoff candle. In his description of this lamp, the inventor sums up its qualities by saying: "It lights and relights itself as often as is required; it only requires one circuit for all the neighboring candles; it replaces automatically those which are entirely consumed, by new carbons; it employs no insulating material which might alter the color of the

flame; and it requires no preliminary preparation of the carbons, which considerably diminishes the expense." The credit of a simultaneous application of the most important principle of this invention has been claimed for Mr. Robert Sabine. Besides these subjects, M. Jamin applied his researches to the compressibility of liquids; hygrometry, on which he was engaged at the time of his death; specific heats; and the critical points of gases. A paper of his on the "Liquefaction of the Elementary Gases," in which the last subject was brought into bearing, was published in "The Popular Science Monthly" for December, 1884. "By their historical order and succession," says "Nature," "his memoirs indicate the progress of physics in France since the middle of the century to the present day." In literature he was one of the regular contributors to the "Revue des Deux Mondes"; and in the earlier editions of the cyclopædias in which his name is given, these articles are mentioned, along with the "Traité de Physique," as the works by which he was chiefly entitled to distinction. He had taste and skill in music. He was a painter of considerable artistic talent, fond of studying the works of the great masters at the Louvre; and was the executor of "an admirable portrait of Lefebvre," of a picture which is preserved in the church in his native village, and of several paintings which are in the possession of his family.

A neat picture of the versatility of his tastes and of his social qualities is given in the sketch of him in "La Nature" and "Nature": "It was only on his return to Paris from Caen that his great power, elevated ideas, distinguished tastes, and fine intelligence could find a free scope. He remembered always with pleasure how at the age of twenty-five he found himself at once surrounded by an intelligent and enlightened society. He dined in a *pension* with several of his colleagues, who have left names either in science or at the university; with Lefebvre, the eminent professor at the Collége Rollin, with Saisset, Barni, Suchet, La Provostaye; with Faurie, who often brought his friend Sturm. The dinner was followed by long chats, with dissertations on science, philosophy, music, and art, in which Jamin took an active part." He was esteemed by all who knew him, scientific men and others, at home and abroad, for many other qualities as well as for his scientific attainments. "Cruelly touched by family affliction," says his biographer, "he found in the midst of his workers who needed continually his aid and assistance, some relief for his great grief. During some time before his death he seemed to have mastered his sorrows, and to have regained his usual activity." He had replaced Milne-Edwards as Dean of the Faculty of Sciences, and at the time of his death was at the height of his reputation. His death came from heart-disease, after an illness of six months.

CORRESPONDENCE.

SAFETY IN THE MANUFACTURE OF HIGH EXPLOSIVES.

Editor Popular Science Monthly:

SIR: The article in Number 180, "Popular Science Monthly," from the pen of Professor L. R. F. Griffin, is a somewhat marked instance of the freedom with which some authors are willing to assume the responsibility of becoming instructors of the public upon topics of interest by expression of authoritative opinion based upon observation of a single phenomenon.

That Professor Griffin has taken this position is clearly indicated, not alone by his erroneous statements of the properties of explosives, but by the freedom with which he charges ignorance on the part of the manufacturers and owners of the explosives stored near Chicago, the explosion of part of which he makes the subject of his article.

Inquiry would doubtless have convinced him that the methods he characterizes as "very strange," are those which the experiences of manufacturers, many of whom are skillful, intelligent, and highly educated, who have had added to their own personal experience the experience of generations of predecessors for their guidance, have taught them to be safest of which we have knowledge. That all methods now in use are the best possible, no one would be so bold as to maintain, but the manufacture of so staple articles as gunpowder, and its recent substitute, dynamite, could not be long successfully conducted by ignorant persons while so many highly intelligent men with necessary capital at command are ever ready to avail themselves of the opportunity for commercial success that would be thus offered; and had Professor Griffin sought information on the subject he treats, from those who have life and large capital staked upon the issue of intended skillful control of explosives during manufacture, transportation, and while stored for distribution and sale, he might easily have avoided the publication of errors that are obvious to a greater number of readers than he may have supposed.

Nitro-glycerine is *not* "commonly absorbed in Richmond infusorial earth," when compounded into what is then known as dynamite, and it is doubtful if, of the millions of pounds of dynamite annually made and sold in the United States, there are one thousand pounds made by the use of infusorial earth; and it would practically be impossible to find offered for sale by any manufacturer or dealer any dynamite, in the compounding of which earth or any other inert matter had been used.

Nitro-glycerine is absorbed and made into dynamite *not* "for convenience," but *solely* for *safety*, and in order to make it commercially practicable to transport from place of production to place of consumption in a form that it may be used—nitro-glycerine, which, as such, no transportation company would receive into its custody.

Any manufacturer of gunpowder who built a magazine depending upon "strong walls and a very light roof" to prevent damage in case of accidental explosion, must have intended to store only a very small quantity, or have been fortunate enough never to have seen or known of the disastrous results of any such futile attempt to restrain or direct the force of the explosion of any quantity such as is usually so stored. Where conditions of the absence of exposure to possible fire, or to the acts of ignorant trespassers would permit, a light frame structure would invariably be chosen for storage of gunpowder. The different properties of dynamite demand structures of a material that will resist or diminish the speed of a stray bullet; but the less resistance from the building within which any accidental explosion may occur, the less will be the damage to surrounding property either by atmospheric effect or by flying missiles.

The simplest knowledge of the properties of dynamite would have prevented Professor Griffin from attributing the non-explosion of other magazines in the vicinity to the fact of their being beyond the "limits where displacement would not appear"—referring to the bodily mass of air; and personal presence in the immediate vicinity of a number of accidental explosions of either gunpowder or dynamite would probably induce him to change his opinion that "the mass bodily displaced must be confined within comparatively narrow limits."

To correct the manifest errors in this short article would require many times the space it occupies, and be less gratification to curiosity than the article itself; and it would seem to have been rather curiosity than desire for investigation or instruction that was inspired in the mind of the author by the explosion of which he has written.

Yours truly, A. O. FAY.

XENIA, OHIO, *March* 29, 1887.

SEX AND BRAIN-WEIGHT.

Editor Popular Science Monthly:

DEAR SIR: In the April number of "The Popular Science Monthly" there was an article, by Dr. William A. Hammond, entitled "Brain-Forcing in Childhood," of which, in so far as it deals with that subject, I have nothing to say here. But the doctor took occasion to have another fling at women, and to that I wish to reply in a way to give him an opportunity to prove, if he can, that his statements are based upon scientific facts and discoveries. If such discoveries have been made they should be on record, and I am assured by the leading men of his profession that no such records exist.

I propose on my side to prove that his statements on this subject, both in this article and a previously published one, from which I shall also quote, are based upon assumption and prejudice, and can not be sustained by scientific tests either by the doctor or any one else.

Since the published opinions of such a man as Dr. Hammond, and in such a magazine as "The Popular Science Monthly," are likely to have a wide influence upon the welfare and prospects of a large number of women, it is most important that he either prove his case or correct his indictment.

In his article on "Brain-Forcing in Childhood" he devotes two and a half pages to a series of statements regarding the native incapacity of woman, the inferiority of her brain in quality, quantity, and development in what brain anatomists call the nobler proportions; and argues that it is an absurdity to allow girls and women to receive and use the means of development which he admits have *produced* these higher results in man!

Cause and effect, in man, he recognizes as related in the usual manner; while cause and effect in woman appear to have no possible connection.

The higher races of man have a higher brain development than have the lower races. This, he argues, is the direct result of the nature, variety, complexity, and accuracy of their mental training and opportunities. Women's brains in the lower races, he says, are very nearly like those of the men; but in the higher races there is a much greater difference between the brains of the sexes; which, oddly enough, he does not attribute to the fact that they have never been allowed the very training and opportunities which he claims produced the desired change in the males of their race. He holds that it is natural, unalterable difference in the brain-mass itself. Now, if this were the case, would not the difference be quite as marked in the lower races? That the disparity is *not* natural and unalterable, but that it is the result of lack of opportunity and inequality of education and environment, seems to be plainly indicated by his own argument when logically carried to its conclusion. But he argues that, since the *ratio* of difference in the brain of the sexes has not remained the same in spite of the great expansion of opportunity for the one and the restriction of opportunity for the other as they rise in the scale of civilized races, it proves *inability* on the part of the restricted sex. And he then asks for further restriction! This is surely as unscientific as it is illogical.*

All this upon the basis that the doctor can prove that such great anatomical differences do exist in the adult brain. But I hold that it never has been done, and that the doctor can not do it. I prepared a number of questions, for which I regret there is not space here, which were submitted to twenty of the leading brain anatomists, microscopists, and physicians of New York, with the results given below.

Dr. Hammond asserts: "Again, it is only necessary to compare an average male with an average female brain *to perceive at once how numerous and striking are the differences* existing between them." (The italics are mine.) He submits a formidable list of striking differences which include these: "The male brain is larger, its vertical and transverse diameters are greater proportionally, *the shape is quite different*, the convolutions are more intricate, the sulci deeper, the secondary fissures more numerous, the gray matter of the corresponding parts of the brain decidedly thicker." Of this latter point the doctor modestly says that the evidence is not so full as might be desired. But, as if all these were not quite enough to enable the merest novice to distinguish a male from a female brain, he offers these re-enforcements: "It is *quite certain*, as the observations of the writer show, that the *specific gravity of both* the white and gray substance of the brain is greater in man than in woman."†

All this would seem to leave woman without a chance of escape; for if by any accident her brain did not fall short in gray matter, fissures, etc., the specific gravity of the rest of it would enable the doctor to

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* "The reason that the brain of the woman is lighter than that of man is, that she has less cerebral activity to exercise in her sphere of duty. *In former times it was relatively larger in the department of Lozère because then the women and the men mutually shared* the burden of their daily labor. The truth is, that the weight of the brain *increases with the use we make of it.*"—*Topinard*, p. 120.

† A recent article in "Mendel's Journal," by Morselli—the only recent article which agrees with this theory—while asserting that the specific gravity is less in the female, is compelled to make the sinister admission that "*with old age* and with *insanity* the specific gravity *increases.*" If this is the case, I do not know that women need sigh for more specific gravity than they have.

ticket her as accurately as though she were to appear with ear-rings and train in a ball-room. Now, if all this is true, it would surely be the easiest and simplest thing in the world to determine the sex of a subject by an examination of the brain alone. And if these "great and numerous differences" are natural, potential sex conditions, and not the results of difference in education, occupation, mental stimulus, and general environment, they would be as easily distinguished in the brains of infants (of the same age, size, and condition) as in the brains of adults.

The physical sex differences which we all know to be natural, necessary, and inevitable, are as easily distinguishable at birth as in maturity.

Now, I am assured by all of the brain experts and scientists to whom my questions were submitted, that the sex of two infants not only *could not* be "perceived at once," but could not be determined at all by these certainly sufficiently plain and numerous differences in brain size, matter, and condition of which the doctor writes so confidently.

And, further than this, I am assured by the leading brain anatomist in America that no careful scientific observer could risk more than a mere *guess* as to the sex of *adult* brains, even upon the most careful and exhaustive examination.

And even more than this, it is a well-known fact that individual brain differences between persons of the same sex are greater and more numerous than any known to exist between the sexes, and that such a guess would, therefore, be worth very little to a scientific mind.

The difference in weight, for example, between the brains of Cromwell and Gambetta, or Byron and Dante, are absolutely known to be far greater than any known to exist between the sexes, as such, even in spite of the relative lighter body-weight of women. But if Dr. Hammond still believes in these numerous and easily detected sex differences in the brain-mass itself—even including the weight test—I am prepared to offer him an opportunity to prove his case, very greatly advance scientific knowledge, and win for himself fame as an original discoverer in a disputed field. If the doctor will agree to it, we can decide whether he can distinguish sex in brain by a very simple experiment.

I will agree to furnish (by permission of the leading brain anatomists and from their collections) twenty well-preserved brains, marked in cipher, Dr. Hammond to divide the male from the female brains by applying any or all of his numerous and readily perceivable sex tests. If he can not do this, he has certainly lost his case.

In the matter of weight the doctor concedes that the *relative* size and weight of the brain are about the same in the two sexes —slightly in woman's favor—which he says does not count; although, when he finds this same relative difference between two men, he argues that it does count for a great deal. But in the dilemma to which this seemed to reduce him he rushes into a most extraordinary statement. He says: "Numerous observations show, beyond doubt, that the intellectual power does not depend upon the weight of brain *relative to that of the body*, so much as it does upon *absolute brain-weight*." Now, if this were true, an elephant might out-think any of us; and the whale, whose intellectual achievements have never been looked upon as absolutely incendiary (if we except Jonah's friend), would rank the greatest man on record, and have brains enough left to equip a fair-sized female seminary.

The average human male brain weighs from 1,300 to 1,400 grammes, and even a very young whale furnishes 2,312 grammes of "intellect-producing substance," as the doctor felicitously terms it; while the brain of a large whale weighed in 1883 tipped the beam at 6,700 grammes!

Truly, then, if absolute brain-weight, and not relative weight, is to be the test, here was a "mute, inglorious Milton" indeed!

Almost any elephant which disports itself for the amusement of small boys—and the enrichment of Mr. Barnum—is several Cuviers in disguise, or perhaps an entire medical faculty.

So much for the "absolute-weight" statement. There are nineteen other points in the doctor's two articles upon which I have data of a nature as radically opposed to his theories and statements as these; but, since lack of space forbids their introduction here, I can add only one other sample. He says, "A fact which is somewhat astonishing to those not aware of it is, that the head of a boy or girl *does not grow in size after the seventh year*." There is no sort of doubt about that being "somewhat astonishing," but there is a vast deal of doubt about it being a "fact." It does not require a "brain-expert" or anatomist to decide that point. Any hatter knows that it is absolutely incorrect. But lest the whole hatting fraternity be not looked upon as an offset to Dr. Hammond's authority, I have permission to state that one of the leading—and I think I will not exaggerate if I say the foremost—brain anatomist of New York has taken such measurements for many years, and in his own family there is a boy whose head has increased in size steadily up to his eleventh year, and still offers abundant evidence of its future intentions in the same direction. This, he assures me, is not exceptional, but is the usual and normal condition.

Of course, the *ratio* of growth decreases, but the size of the head increases in most persons up to the twentieth year, and usually until about the twenty-fifth.

Sincerely yours,

HELEN H. GARDENER.

A NATIONAL EXPLORING EXPEDITION.

Editor Popular Science Monthly:

DEAR SIR: Whatever the influence has been that has been brought to bear for the past five or six years or more, it certainly has had the effect of moving Congress to appropriate money toward the building of some new war-vessels for our navy, and improving our coast-defenses. No doubt all this was very necessary; but do you know that the signs of the times prompt me to suggest that there are other things that our navy might be doing during these long days of peace, which would reflect far more credit upon us as a nation than if we had the most powerful fleet of war-vessels afloat in the world? Civilized nations are rapidly coming to that chapter in their history wherein it will be plainly shown that those states which will command the greatest measure of respect among us will be the ones which have best advanced the progress of science, art, and learning, and developed the culture that accrues therefrom, and not those who can cast the biggest cannon, and invent engines which will kill the greatest number of human beings in the shortest space of time. Even aside from this, it would almost seem as if our people overlook the fact sometimes that were Congress to appropriate to-day sufficient money to build a navy for this country which would be equal to the navies of such nations as England, France, or Italy, before we would have the opportunity to use it in actual warfare it would be thoroughly outstripped again by the marvelous rapidity of the improvement that is constantly going on in naval architecture. The nations I have mentioned have to be constantly renewing their war-vessels in order to keep up with the advance in such matters, and are continually selling their old patterns to the lesser powers. We have not the competition in the United States to excite any such movement as this, and the men-of-war we build to-day will in all probability be as absolutely powerless to compete with the massive floating steel and iron fortresses of France and England of the future, as if we were to build them as invulnerable as those vessels now are, and attempt to engage with what the same nations will surely possess twenty-five years hence.

One of the great outcries made by the officers of our navy is, that "we are not held in the proper respect on foreign stations," or, in other words, our puny little fishing-smacks do not favorably compare with the ponderous ironclad hulks that represent the naval powers of the world, and tower over them.

Now, I have a notion that the United States would gain an enormous amount of respect in the eyes of foreign nations, if not in the eyes of foreign navies, had she upon any foreign station one of her very best men-of-war and two corvettes, completely remodeled and thoroughly equipped both as regards men, officers, and scientific staff, and the necessary appliances to properly prosecute an exploring expedition around the world. It would seem to me that the commander of such a little fleet, were it anchored in the harbor of Shanghai or Rio Janeiro to-day, would feel a far greater pride in his country than were he in command of a *seventeenth-rate* gunboat, comparatively speaking, and there should steam in, with flying colors, such an infernal engine of destruction as the French man-of-war the Foudroyant or the Dévastation. With all the iron and steel we could rivet on to some of our best war-vessels to-day, they could not be made sufficiently effective to engage, with the slightest hope of success, such vessels as the two I have mentioned. Yet a very moderate expenditure on the part of Congress would splendidly refit them for exploring vessels in every sense of the word, and render them creditable institutions of the nation.

I am convinced that the day will come in the history of the world, whether we hold together as one country or not, when all the exploits of our navy during the war of the rebellion will pale, so far as the credit to humanity is concerned, by what was accomplished by the Wilkes Exploring Expedition; and England will blush when she compares the victories of her Nelson with the results obtained by the Challenger Expedition, and confesses to humanity which was the more important to the progress of the world.

Smile if you will, but I believe the day is coming for us in our race when national disputes will be settled without costing a million lives, and the breaking a million hearts—when war between countries will be as much a thing of the past as the duel is now between individuals; and finally, when the functions of our brain will prevail over the inherited instincts that came down, or perhaps I had better said passed up with us, along with our canine teeth.

Let us repeat, at as early a day as possible, the Wilkes Exploring Expedition, and see whether we do not gain credit, respect, and power by the movement, to say nothing of all that is sure to accrue from it in other particulars. Very respectfully,

R. W. SHUFELDT.

FORT WINGATE, NEW MEXICO, *March* 7, 1881.

EDITOR'S TABLE.

HIGHER EDUCATION OF WOMEN.

THE interest which this subject is exciting at the present moment is, we take it, a very hopeful sign. The probability would appear to be that, in the clash of opinions, the truth will gradually be beaten out. Every writer brings to the question his or her own contribution of real experience; and, when once we have the facts properly sifted, it will not be such a difficult matter to draw conclusions.

Mrs. Lynn-Linton in England has taken up a position on this subject that places her in antagonism to most of those who have espoused what, for convenience, we may call the women's side of the question. She does not say that women can not take the highest education or make the best use of it, but on the whole she rather discourages, from a practical point of view, the effort to bestow the highest education on any very large number of women. We do not wish to be understood as committing ourselves to all the views she has advanced; but we think she has at least made one forward step by importing certain simple practical considerations into the discussion. She has shown that an advanced education has an appreciable money value to young men in a much larger proportion of cases than it has to young women. Much as we may talk of "education of the mind" and "discipline of the faculties," the education of boys and young men has mainly been dominated by practical ends. We are far from saying that those ends have always been wisely sought; we simply contend that in general they have been recognized. When a young man has been destined for the bar, for the Church, for the profession of medicine, or for some scientific or literary career, there has been a special object in giving him as liberal a preliminary education as possible; and such courses of higher education as have heretofore been devised have had as their main intention the fitting of men for professional careers, and not the mere production of a large number of finely polished intellects destined for no particular function whatever. It may be further said that, in the education of men, the definiteness of the ulterior aim has been to a large extent the circumstance that has rendered the imparting of a sound education possible. The mind can carry what it means to make use of, what it expects to find serviceable, far better than it can what does not point to any special application. The education of men has thus been given a certain concreteness and a certain actuality from the fact of its bearing, or, at the very least, being understood to bear a distinct and definite relation to practical life.

How is it, now, as regards the education of women? It is certainly true that women are taking to-day a much wider share in the work of the world than they did even a generation ago. Many more careers are open to them, and their ability to assume even the most difficult professional duties is no longer doubted. Manifestly, then, a practical necessity has arisen for placing within the reach of women the highest educational advantages. It can hardly, however, be maintained that the somewhat clamorous demand that has been made of late years on behalf of women for such advantages has been mainly inspired by the desire to enable women to hold their own in various professional walks. The object has rather been to produce a generation of gifted women without reference to any special practical use to be made

of their high accomplishments. "Culture" for culture's sake has been the idea, rather than culture for the sake of more efficient *work*. Now, we are well aware that to some it will sound like a great heresy, but we must frankly confess that we do not believe in culture for culture's sake, nor in art for art's sake, nor in science for science's sake, nor even in truth for truth's sake. We believe that culture and art and science and truth all find their value in the *human life* which they tend to beautify and improve. When culture is given merely for culture's sake, it lacks definiteness of aim, and never seems to know what boundaries to observe. We fancy—though at this moment we are not prepared to speak positively on the point—that we see a result of the "unchartered freedom" of female education in the more ambitious programmes of female seminaries as compared with those devoted to the teaching of young men. Men know that they must concentrate their energies if they are to succeed in the special objects they have set before them. Women, not having (in general) such special objects, think the whole circle of knowledge none too vast for their grasp. We read in a recent article by a lady upon a well-known college for ladies that, "in passing from class-room to laboratory and lecture-room, while observing the work done by professors and students, one can not fail to be astonished at its breadth and depth and wide scope, at its immense quantity and superb quality. Pages would be required to do it full justice." Is there any college for men in this country to which such a description could be applied without seeming somewhat overstrained? We certainly do not remember to have seen anything so glowing of either Harvard, Yale, Johns Hopkins, or Columbia.

Supposing, now, we ask for a moment, What is "higher education" for any given individual? we should be inclined to answer—with that bent toward practical views which we have already avowed—that it is not so much education in the minutiæ of any branch or branches of knowledge, as education dominated by a relatively high purpose and expressly directed to the perfecting of the individual life with reference to its normal sphere of activity. Now, individual life is not perfected, not improved, by any education that ministers to vanity or ambition. That the college education of young men often has that effect we are quite sure; that the college education of young women has it still oftener we are disposed to believe. Anything that has such an effect forfeits, in our opinion, its title to be regarded as "higher education," since it really is the education and stimulation of lower impulses and instincts. Apart from this consideration, however, true intelligence is not always promoted by the imparting of a great variety of knowledge, or even by the special prosecution of particular lines of study. Whether the mind becomes truly intelligent depends upon whether it is enabled to apply to every-day life the lessons of the school-room, and to see all knowledge in its practical bearings. Many minds, male and female, are, we are convinced, simply educated away from true intelligence by the costly efforts that are made to give them the highest educational advantages. As between men and women we draw at present no line whatever in respect to intellectual qualifications. That the distinction of sex extends to mind as well as to bodily organization we think highly probable; but precisely how the distinction operates in the mental region can not be dogmatically affirmed; and the best thing to do under the circumstances is to let the distinction, if there is one, establish itself in practice. Let the same educational facilities and privileges be available for women as for men; and in the course of time we shall perhaps see better than we do now

what modifications need to be introduced into the education of women. The principle of equality once firmly laid down, it remains to be said that, from the point of view of the intellectual future of the female sex, too much importance probably is being attached to what is called "higher education." It is safe to say that such intellectual advantages as men now enjoy are but in a minor degree dependent on colleges and universities. We constantly see men arriving at high scientific and literary eminence, with little or no aid from scholastic institutions; and what is possible for men is possible for women. The last thing we should wish to do would be to disparage systematic training; but still it is an indubitable fact that many have contrived to accomplish great things without it. Upon the whole, it is an encouraging thought that "higher education" is not confined to seminaries of learning. It can be imparted largely in the home-circle; it can be obtained by independent study and reflection. Let the seminaries flourish, but let it be understood that common sense and right feeling, and worthy aims in the household and in society, constitute in themselves the conditions, and even in some degree the elements, of higher education. We should like to see this whole question reduced to its true proportions and brought into direct relation with the realities of life. We believe that women (like men) have at the present moment within their reach far more extensive means of culture than they care to avail themselves of; and that what is really wanted for the diffusion of higher education in the best sense is not so much the multiplication of institutions of learning, as the communication of an impulse to individuals of a nature to lead them to lay hold of the means of intellectual improvement that abound on every side. Could this be accomplished, the general intelligence of society would advance with rapid strides; while the multiplication of institutions of learning, and dependence on them for intellectual results, will only give us a select class of educated, sometimes over-educated, persons, and will leave society at large but slightly modified by the culture that really ought to mark this advanced stage of human progress.

THE GREEK QUESTION AGAIN.

Since the article on the "Present Status of the Greek Question" appeared in the May number of "The Popular Science Monthly," we have been informed by a graduate of the University of Cambridge, England, that it is now possible to obtain the degree of B. A. from that ancient institution of learning without any knowledge of Greek whatever. This marks, of course, a new era in the history of this question in England.

It may be worth while to glance for a moment at the amount of Greek required for the B. A. at the various British universities where it is still insisted upon as a required subject of examination. We have not the requisitions of Oxford before us, but we are assured that they do not exceed those of the University of Edinburgh and other Scottish universities for the M. A. According to the "Edinburgh University Calendar" for 1883–'84, the Greek set for examination for the degree of M. A. comprised the following: "Odyssey," book vi; Sophocles's "Electra;" Thucydides, book vi, and Plato's "Protagoras." Now, when we consider that these authors and the particular works or portions of their works to be set are thus announced a year beforehand, it will be seen how small an amount of work in Greek is really required for this degree. It does not amount to more than is required for entrance to the classical course of any good American college. A Cambridge graduate has asserted that it was quite feasible for a man, in the days when Greek was required at Cam-

bridge, actually to commit to memory the portions of Greek set, and to go through the examination successfully after two or three months' hard grinding, without obtaining the shadow of an idea of Greek grammar even, to say nothing of Greek literature or history! Of course, no sane man would maintain that in the case of men who actually did this any such advantage in the way of culture and mental discipline could accrue, as is claimed for the study of Greek in general.

It is very curious to compare the views of the adherents of compulsory Greek in Germany, England, and America. They all agree in maintaining that the course of required Greek in their respective countries accomplished wonders in the way of education. When we compare, however, what is actually required for graduation in a German gymnasium, for example, in the A. B. course at Cambridge, and in an A. B. course in any American college of good standing, we find that the course in Germany requires fully six years of earnest study; in America at least four or four and a half; and in England not over two or three at the very most. The German apologist for Greek would maintain, however, that the small amount required in America or England is not worth a rush (as indeed some of them have said in answer to a proposition to diminish the amount of Greek required to something like the American or English standard, and that they had better cut it out altogether rather than treat it in such a "stepmotherly" way); the American claims that the small amount given in England is of little or no value, and insists that the present requirements in America shall not be cut down.

Outsiders can hardly be blamed for coming to the conclusion that the Germans are right, and that we should either require enough to make it worth the while, or else cut it out altogether from the list of required studies. As it is not at all likely that the amount required will ever be increased, the only thing to do is to get rid of that little which according to the most competent judges is worth nothing at all.

We would not be misunderstood, or have opinions ascribed to us which we do not hold. We do not desire to attack the study of Greek or the policy of offering the most ample facilities for its pursuit. On the contrary, we consider that from no branch of study can one whose tastes lie in that direction derive more benefit in the years before he takes up special lines of work than from Greek. But we can not disregard the fact that such pupils are usually only one or two among a large class who are looking forward to some higher course of instruction, who succeed in accomplishing more than merely to drag through the prescribed course. We believe that many students, who might be capable of showing marked talents in other directions have been deterred from advancing to higher courses of instruction by the fact that Greek lay in the way. In schools dominated by the classical spirit, every sort of talent is measured by its ability to make grade in the classics. All who can not come up to this standard are made to feel that they are considered inferior students. They are "specials," or "partials," or "generals," or something else, which implies that they are not so good as the regular classical students. We can not but think that this fact has lain at the bottom of the failure of many a one in the past, who under a different system would have been quickened to a new intellectual life and raised into a higher sphere of usefulness.

The notion that liberal views of life, wide intellectual sympathies, a broad humanity—in a word, that all those qualities that should distinguish a gentleman and a scholar from his opposite—are the exclusive products of one line of studies, may be, we think, properly

enough characterized as a fetich; and it is a fetich which has done and is doing much harm in the educational world. We believe it is losing its hold upon the minds of men very rapidly, and that we have great reason to congratulate ourselves upon this fact. Its final destruction need not, and we do not think it will, lead to the disappearance of Greek from our courses of liberal study, but it will deprive it of that peculiar position of predominance which it has held in Western education for the last three hundred years—a predominance which, however beneficial at some stages of our modern era, is now the source of far more injury than benefit.

ANNOUNCEMENT.

THE editor takes pleasure in announcing the commencement, in the July number of "The Popular Science Monthly," of a series of articles, by David A. Wells, on the economic disturbances commonly spoken of as "A Depression of Trade and Industry," which have prevailed to a greater or less extent throughout the whole civilized world since the years 1872-'73; and, in the opinion of not a few economists and investigators of repute, are yet very far from having come to an end. The subject, considered either historically, or in view of its bearing on industrial progress, the accumulation and distribution of wealth, and the relations of capital and labor in the future, is one of the highest interest, and has already engaged the attention of several national commissions on both sides of the Atlantic. It is almost unnecessary to state that the author brings to its discussion—which necessarily involves the phenomena of the so-called "over-production," the discontent of labor, the depression of prices, bimetalism, and the increasing tendency among nations to impose artificial restrictions on trade and commerce—the results of very thorough study, as well as world-wide reputation for determining and popularly presenting economic facts and conclusions. Mr. Wells is known as a trained observer, who looks at things with judicial fairness, and has formed the habit of arriving at his opinions independently of all prejudice, and of presenting them with candor and precision. It is, therefore, reasonable to anticipate that his conclusions will command, as they deserve, very general attention.

LITERARY NOTICES.

INTERNATIONAL EDUCATION SERIES.

THE RISE AND EARLY CONSTITUTION OF UNIVERSITIES, WITH A SURVEY OF MEDIÆVAL EDUCATION. By S. S. LAURIE, LL. D. New York: D. Appleton & Co. Pp. 31 + 293. Price, $1.50.

THE many teachers, parents, and others who are forced to decide between conflicting policies in higher education will be greatly helped toward an intelligent decision by a study of the methods which prevailed in the early universities. It is the aim of the third volume of the "International Education Series" to present a general survey of these methods. The author begins with a sketch of the schools whose character was determined by the union of Roman and Hellenic culture in the time of Augustus, and traces their decline after the Christianizing of the empire, and the rise of Christian schools in their stead. The influence of Christianity at first was to discourage the earlier culture, as tending to foster paganism, or, at best, as being a mere dissipation. All teaching in the Christian schools was with a view to pious uses, and the curriculum was generally restricted to arithmetic, reading the psalter, and music. These schools had reached quite a promising condition in the sixth century, but retrograded in the seventh and eighth, so that when Charlemagne became Emperor of the West the education of Europe was in a barbarous state. This monarch made the improvement and extension of the episcopal and monastery schools an important part of his policy. To his court at Aix he invited such

men of learning as could be found. The emperor was fond of music, and promoted the reform of church singing, introducing the Gregorian Chants, and it is said, also the organ. But his reform in education, and that of Alfred in England a half-century later, were temporary in their effects. During the three centuries after the death of Charlemagne, learning languished in Europe, but among the Arabs at this period it was flourishing. About 1100 there arose *studia generalia*, or what we should now designate as professional schools, called forth, as Professor Laurie believes, by the growth of learning demanding specialization, by the rise of a lay feeling in connection with the work of the physician, the lawyer, and even the theologian, and by the actual specializing of the three leading studies at different centers of instruction. These schools were open to all the world, free from monastic rule, and self-governing. The name *university* came later. In 1224, Frederick II combined the three faculties with a school of arts at Naples, and incorporated the University of Naples, with definite authority and privileges. The University of Bologna first became noted as a school of civil law; later instruction in canon law, arts, medicine, and theology, came to be given. The University of Paris had a similar gradual development. The term *universitas* had at first no reference to the scope of the curriculum, but meant simply a community. In form of government, the literary communities copied the free trade-guilds. The rights to practice and to teach medicine were the first degrees. The degree of *Baccalaureus Artium* originally marked the end of what was regarded as a preparatory course, fitting the student to commence his study in arts for the master's or teacher's degree. Professor Laurie sets the time of the beginning of university life at Oxford, at about 1140, and at Cambridge about 1200, and he thinks their university organization arose about 1230, after the large migration of students came to them from Paris. The University of Prague, founded in 1348, by Charles IV, was the starting-point of the great German system of universities. It followed the plan of Paris, where Charles had been a student. In his closing chapter Professor Laurie gives an interesting account of the university studies and the conditions of graduation in the twelfth and thirteenth centuries, from which the reader may learn how many current academic forms are survivals of mediæval practices.

ELEMENTS OF PHYSIOLOGICAL PSYCHOLOGY. By GEORGE T. LADD, Professor of Philosophy in Yale University. New York: Charles Scribner's Sons, 1887. Pp. 696. Price, $4.50.

WE consider this the best book that has ever been published in America upon that particular branch of psychology of which it principally treats. It deals chiefly with the nervous mechanism and correlations with the mind, embracing under the latter head questions of the localization of cerebral functions, the quality of sensations, their quantity, the various presentations of sense, the time-relations of mental phenomena, feelings and motions, the physical basis of the higher faculties, and certain statical relations of the body and mental phenomena. Thus far and within these limits the book is excellent. The latest results of the study of mind from the physical point of view are thoroughly exhibited. The fruits of German study are especially well presented, and the recent work done by the Johns Hopkins University scholars in establishing the existence of the temperature sense, we are glad to see, meets, with the author's recognition. Without taking the space to particularize merits, and without searching for particular and minor defects, we are justified, upon the whole, in commending highly this work as far as the close of Part Second.

The third part, entitled "The Nature of Mind," ought to have been entirely omitted. It is not only superfluous, but painfully unsatisfactory. No sufficient foundation is laid for what is said, and the treatment itself is extremely inadequate. Until the other branches of psychology beyond the physiological are considered, even hypotheses or surmises respecting the ultimate nature of mind are out of place. The author in his introduction attempts to justify the metaphysical discussions and theses with which the work closes on the ground that psychology inevitably leads up to philosophical questions, and must furnish the basis upon which they are to be answered. Undoubtedly so; but that does not warrant a writer who makes

a book covering only a portion of psychology in giving us his metaphysics as if established by psychology generally. His work presents only a part of the data, and until he has gone over the whole ground he has no business with ultimate questions. The topic, "The Nature of Mind," is indeed interesting, but it is greatly to be regretted that Professer Ladd could not restrain himself from discussing it until the opportunity was afforded in some clearly appropriate connection.

A TREATISE ON SURVEYING, COMPRISING THE THEORY AND THE PRACTICE. By WILLIAM M. GILLESPIE, LL. D. Revised and enlarged by CADY STALEY, Ph. D. New York: D. Appleton & Co. Pp. 549 and 127. Price, $3.50.

PROFESSOR GILLESPIE'S standard treatise on "Land-Surveying," published in 1855, was prepared with a view of producing "a very plain introduction to the subject, easy to be mastered by the young scholar or the practical man of little previous acquirement, the only prerequisites being arithmetic and a little geometry; and at the same time to make the instruction of such a character as to lay a foundation broad enough and deep enough for the most complete superstructure which the professional student may subsequently wish to raise upon it." A second work, on "Leveling and Higher Surveying," was left unfinished at the author's death, but was completed by the editor of the present volume, and published in 1870. These two works have now been revised and combined by Dr. Staley. The general divisions of the resulting treatise are land-surveying, leveling, topography, triangular surveying, hydrographical surveying, and mining surveying. Somewhat more than half of the body of the volume is occupied with the first of these divisions, comprising minute descriptions of instruments, directions for making measurements, keeping field-notes, platting surveys, and practical instruction in laying out, parting off, and dividing up land, including the methods used in surveying the public lands of the United States. In the section on leveling, spirit-leveling receives most attention, and brief accounts are given of the methods of trigonometric and barometric leveling. Under topography, modes of topographical representation are abundantly illustrated, and the use of the plane table is described.

An Appendix is devoted to a synopsis of plane trigonometry, and another takes up certain theorems relating to transversals, harmonic division, and the complete quadrilateral. Following these are an analytical table of contents, traverse-tables, tables of chords, logarithms, logarithmic sines, etc., and natural sines, etc., a stadia table, and a table of refraction in declination. The volume contains abundant illustrations of instruments and operations, and an isogonic chart of the United States for 1885-'86.

SOCIAL STUDIES. By R. HEBER NEWTON, New York: G. P. Putnam's Sons. Pp. 380. Price, $1.

THIS is a collection of essays on social questions, some of which appeared originally as articles in periodicals, while others were prepared for special occasions; thus, three of them were read before the Church Congress; one before the United States Senate Committee on Education and Labor; one at the annual banquet of the Chamber of Commerce; and one before the Free Religious Association. The titles are: "A Bird's-Eye View of the Labor Question"; "The Story of Co-operative Production and Co-operative Credit in the United States"; "Is the State just to the Workingman?" "Old-Time Guilds and Modern Commercial Associations"; "The Prevention of Intemperance"; "Moral Education in the Public Schools"; "The Free Kindergarten in Church Work"; "The Religious Aspect of Socialism"; and "Communism."

THE WESTMINSTER REVIEW. Vol. 128, No. 1. April, 1887. London. Trübner & Co. New York: The International News Company.

THIS Review, now in its sixty-fourth year, with the current number makes a new departure. Henceforth it will be issued monthly, and various changes will be made in the direction of suffusing the work with fresh vigor and adapting it to altered conditions of the reading public. Among other things it promises to "give special attention to the literature of science," and that "the exposition and discussion of scientific subjects (which, in comparison with the whole of the other departments of intellect-

ual activity, have now attained commanding pre-eminence and supreme importance) will in future constitute a distinctive feature of the work." We understand that the intention is to allow about three eighths of the space of each monthly issue to American contributions; of the latter there are two in the number before us, both excellent articles: one, by Hon. Oscar S. Straus, United States Minister to Turkey, upon the "Development of Religious Liberty in America"; the other, by Thomas G. Shearman, Esq., entitled "The Protectionist Revival in Great Britain." These articles have an American copyright. The next number, we are informed, will contain an article by Mrs. Clara Lanza, of this city, upon "Fiction as National Literature," and another by Horace E. Deming, Esq., also of New York, upon "The Machine in American Politics."

TABLES FOR THE DETERMINATION OF COMMON MINERALS. By W. O. CROSBY. Boston: J. Allen Crosby. Pp. 74.

THE reasons which have led Professor Crosby to publish these tables are that the best tables which have preceded them are overloaded with descriptions of minerals seldom met with, and give determinations based largely on chemical properties, which are not so conveniently ascertainable as the morphologic and physical properties. Professor Crosby's tables, which are an outgrowth of his experience as an instructor at the Massachusetts Institute of Technology, aim to determine about two hundred species —all that the student is likely to have occasion to identify—by their more obvious physical and structural features, adding chemical tests to be used when the identification is not otherwise perfectly satisfactory. Only those tests have been selected requiring the minimum of apparatus, reagents, and previous chemical training. The properties of minerals, and the chemical and blow-pipe tests referred to in the tables, are explained in an introduction. In the tables, minerals are divided first into two classes, those with metallic and those with non-metallic luster, and then by the color in the former class and the streak in the latter, and further by the hardness; they are subdivided into forty-one groups. A concise physical description of each species is given, by which it may be distinguished from the others of the same group, and the last column of the tables is devoted to chemical tests. An index of species is appended.

THE ARGENTINE GENERAL CATALOGUE. Mean Positions of Southern Stars determined at the National Observatory, BENJAMIN A. GOULD, Director. Cordoba. 1886.

THIS volume puts the public in possession of the main results of Dr. Gould's great labors in Cordoba. The catalogue contains 32,448 stars, and there are many hundreds more in appended lists of clusters, the number of observations exceeding 145,000. The work includes nearly all the stars in the southern heavens, down to the 8½ magnitude, the exceptions chiefly lying north of 23° of south declination, a region already covered by other catalogues. Of the surpassing accuracy of the work, and the minute care with which every part of it has been executed, it would be impertinent for us to speak. To the layman, the contemplation of such a monument of genius, bending itself to incalculable assiduity, is truly a moral lesson.

A SYSTEMATIC HAND-BOOK OF VOLUMETRIC ANALYSIS. Adapted to the Requirements of Pure Chemical Research, Pathological Chemistry, Pharmacy, Metallurgy, Manufacturing Chemistry, Photography, etc., and for the Valuation of Substances used in Commerce, Agriculture, and the Arts. By FRANCIS SUTTON, F. C. S., F. I. C. Fifth edition. Philadelphia: P. Blakiston, Son & Co. Pp. 491. Price, $4.50.

WHEN discoveries of chemical reactions and methods are being published so voluminously as at present, frequent revisions are necessary to keep a manual of analysis abreast of the times. In preparing this edition of his hand-book, Mr. Sutton has completely revised the work, and has added new methods. He has excluded some of the matter of previous editions as being of little value, among which is the systematic analysis of soils and manures by volumetric methods, also that of indigo, for which no satisfactory process is known. The opening section of the book is devoted to a description of apparatus and instruments. The second section is on analysis by saturation, and comprises alkalimetry and acidimetry, including in each division

the examination of a number of commercial products. This section includes descriptions of the new indicators derived from the azo-colors, which have been introduced recently by R. T. Thompson. The third section deals with analysis by oxidation or reduction, and the fourth with analysis by precipitation. The foregoing principles are then applied to the estimation of the important elements and radicals, which are taken up in alphabetical order. A chapter is devoted to the analysis of urine, potable waters, sewage, etc., and another to gas analysis. In the latter field there has been marked improvement in technical processes since the last edition of this work was issued. The book is well supplied with illustrations showing forms of apparatus, and methods of arranging it for special operations.

MINERAL RESOURCES OF THE UNITED STATES. 1885. By ALBERT WILLIAMS, JR. Washington: Government Printing-Office. Pp. 576.

THE present volume is the third of a series designed to present the principal statistics concerning the mineral productions of the United States, together with such descriptive matter as will throw light upon the condition of the industries which those products materially affect, or will aid in utilizing material which has no value at present. The first volume covered 1882 and the first half of 1883; the second volume continued the record till the end of 1884. These volumes were noticed in the "Monthly" when they appeared. The present volume includes the calendar year 1885. The material for the accounts has been obtained by canvass for precise returns where that was practicable; otherwise, from estimates of authorities as checked by actual returns from all available sources. Much of it appears in the form of special articles by persons who are experts, or have given particular attention to the subject. The principle is observed of not repeating (except in the tables) information given the previous year; hence it happens that, where no change has been made in the conditions, attending any product, that title may temporarily disappear from the record. Prominence is given in the presentation to coal, coke, petroleum, natural gas, and the economical metals under some of which headings several articles of special value appear. Thus, Mr. Joseph D. Weeks treats of the manufacture of coke, of natural gas, manganese, and glass materials; Mr. S. H. Stowell, of petroleum; J. M. Swank, General Manager of the American Iron and Steel Association, gives a review of twenty-one years of progress in manufacture; C. Kirchhoff, Jr., contributes articles on the copper, lead, and zinc industries of the United States; Mr. David T. Day, on chromium, zirconium, phosphatic rock fertilizers, and iodine; Mr. N. S. Sproule, on structural materials; Mr. George F. Kunz, on precious stones; William C. Day, on sulphur and feldspar; Herbert J. Davis, on pyrites; Marcus Benjamin, on mineral paints; G. F. Perrenoud, on talc; and A. C. Peale, on mineral waters.

A TREATISE ON ALGEBRA. By Professors OLIVER, WAIT, and JONES, of Cornell University. Ithaca, N. Y.: Dudley F. Finch. Pp. 412.

THIS work is a text-book for college classes, being planned especially for the classes conducted by its authors. It is, therefore, not a book for beginners, but for students who have already studied the elements of algebra and geometry. In writing it the authors have had two rules for their guidance. One was, to assume no previous knowledge of algebra, but, starting from primary definitions and axioms, to develop the elementary principles in logical order; the other was to define clearly every word and symbol used in a technical sense, to state formally every general principle, and, if not an axiom, to prove it rigorously, to state formally every general problem, and to give a rule for its solution with reasons, examples, and checks. The book contains much matter that is not found in the common college algebras—more, in fact, than can be used with ordinary classes—yet its wide range is expected to make it valuable as a reference-book for teachers, and as a guide for students who wish to pursue the study beyond the usual limits. The authors have pursued a course which they believe accords with the tendencies of modern algebraic work, in utilizing graphic representation, the elements of infinitesimal analysis, and the

calculus of operations, for the purpose of attaining a natural and philosophical presentation of the subject. Symbolic language has been largely employed; in some cases larger meanings have been given to old words, and new words and symbols have been introduced. Another edition is to contain chapters on the theory of equations, integer analysis, symbolic methods, determinants and groups, probabilities and insurance, and an index will be added.

THE SCIENTIFIC WRITINGS OF JOSEPH HENRY. Washington: Published by the Smithsonian Institution. Two vols. Pp. 523, 559.

THESE volumes comprise the first collection that has been made of Professor Henry's scientific writings. The original papers, having been given to the world from time to time through a period of more than fifty years, and published in widely remote places, are now generally rare, and in many cases nearly inaccessible. Their value, even at this time, as we glance over them in these handsome volumes, might well strike with surprise persons who, recognizing how much advance has been made in research during the last sixty years, would naturally imagine that they were superseded by what has been discovered since they were written. But most of them were in the lead of the science of the time of their production, and some of them, even on subjects now of the most lively investigation, read as if they might have been written to-day. It was a becoming act in the Regents of the Smithsonian Institution to present these writings in the noble shape in which they appear; and we can join with them in the feeling which they express that it seemed to them "that justice to the name and memory of their distinguished Secretary who made the Institution what it is, no less than a due regard to the history of physical science in this country, and the interests of its present votaries, require that these writings should now be collected and made available." The act is all the more graceful, because, as the regents also observe, "it is noteworthy, and indeed is characteristic of their author, that he sedulously abstained from publishing any of his researches of the later period or reproducing any of the earlier ones—very important though he knew them to be—through the inviting channel of the 'Smithsonian Contributions,' or 'Miscellaneous Collections,' or in any way at the expense of the Smithsonian fund." The writings are naturally grouped under two periods: the first, comprising the record of the author's researches from 1824 to 1846, during his professorial career at Albany and Princeton; and the second that of his scientific work from 1847 to 1878, during his directorship of the Smithsonian Institution at Washington. The arrangement of the papers is chronological, except that the series recording the author's observations on the phenomena of sound are, for the sake of equalizing the size of the volumes, removed from their proper position in the second volume to the end of the first volume; and the second volume is made to begin with a continuous presentation of the series of meteorological essays. The publication is made under the direction and supervision of Dr. Asa Gray, the Hon. W. L. Wilson, and Professor S. F. Baird, committee.

TRANSACTIONS OF THE MODERN LANGUAGE ASSOCIATION OF AMERICA. 1884–'85. Vol. I. Baltimore: Published by the Association. Pp. 250: MODERN LANGUAGE NOTES. A. MARSHALL ELLIOTT, Managing Editor. Eight numbers a year. Baltimore. Pp. 48. Price, 15 cents a number.

WE have already noticed the formation of the Modern Language Association, and its objects, which may be briefly expressed as to encourage and exalt the study of the modern languages, and to secure to them their equal place of consideration with the ancient languages and other branches of college study. The present volume of its "Transactions," with its eighteen papers on various aspects of the subject, shows how well it is working to its purpose. Two of the papers are mainly literary. A half-dozen of them may be grammatical. Professor Alcée Fortier gives an interesting account of "The French Language in Louisiana and the Negro-French Dialect." The other papers refer more or less directly to practical questions of instruction in modern languages and English literature. Professor W. T. Hewett considers the aims and methods of college instruction in modern

languages; Professor N. G. Brandt inquires how far our teaching and text-books should have a scientific basis; and Professor J. M. Hart, how the college course in English literature may be improved. Professor F. V. N. Painter outlines "A Modern Classical Course"; Professor T. W. Hunt defines the place of English in the college curriculum; and Dr. Francis B. Gunmere asks, "What Place has Old English Philology in our Elmentary School?" "German Classics as a Means of Education" (Goethe) is discussed by Dr. Julius Goebel; "The Requirements in English for Admission to College," by Professor G. R. McElroy; "The Use of English in teaching Foreign Languages" by Professor H. C. G. von Jagemann; and "The Real-Gymnasium Question," by Professor A. Marshall Elliott.

The "Modern Language Notes" began its second year with the January number, 1887, considerably more than twice as large as was the first number, yet with price unchanged, and with subscriptions and advertising lists that have more than covered expenses since the sixth issue. The matter is of a piece with that of the "Transactions," with the addition of book reviews, brief paragraphs, and such current news as has a connection with modern language studies. It is intended henceforth to give, with running comments, the titles of leading articles appearing in foreign journals devoted to the modern languages, and to keep abreast with the best production in this branch of linguistic science.

THE AMERICAN NATURALIST. Vol. XXI. No. 1. January, 1887. Philadelphia: J. B. Lippincott Company. Pp. 110. Price, $4 a year.

WITH the beginning of the current year, this periodical passed into the hands of the J. B. Lippincott Company, of Philadelphia. Professor Cope continues as leading editor, while Professor Packard, his associate, retires, and is succeeded by J. S. Kingsley. With these gentlemen co-operate seven experts in their special branches of science as "Department Editors" in Geography, Mineralogy, Botany, Embryology, Physiology, Anthropology, and Microscopy. The publishers announce that the history of the "Naturalist" during the twenty years of its existence has been one of gradual development, that its subscription list now much exceeds that of any previous period, and its prosperity is fully assured. It is creditable to our people that this should be so, for appreciation of a journal of this character, and of one that maintains so high a standard as that of the "Naturalist," is a sign of no ordinary degree of cultivation, and of a desire to learn science by working in it. The "Naturalist" was a pioneer in its field, and it occupies a sphere which no other journal so fully and so peculiarly fills. In last year's volumes original articles appeared from one hundred American naturalists, and a like list of contributors is in prospective for the present year. In the hands of so extensive and successful a house as that of its new proprietors, its opportunities for usefulness are certain to be greatly increased.

LATIN WORD-BUILDING. By CHARLES O. GATES. New York: D. Appleton & Co. Pp. 160. Price, 98 cents.

THIS manual is intended to aid in removing the difficulty which Latin students feel in translating at sight, growing out of ignorance of the exact meaning of the root-words. Experience has taught that the vocabulary is more readily mastered and exact and definite meanings of words are more easily acquired and retained by making familiar the significance of the roots and associating with it the meanings of the modifications, with affixes and suffixes, endings, etc., by which they are affected, and so reaching the significance of derivative words by a kind of general rule, than by looking out all the words singly in the dictionary. The manual aims to assist in this process. The method is, first, to learn the exact meaning of the root-word; then to acquire the definite meanings of the more common words derived from the root-word; and then to utilize the information thus gained by translating sentences illustrating these words from the author next to be read in regular course. The first part of the volume comprises an etymological vocabulary, in which the meanings of the root-words, their modifications, and groups of their derivatives are given, with space left on the page for the insertion by the pupil of such new mat-

ter as his readings may suggest. The second part contains sentences from Cæsar and Cicero, to which what is learned from the vocabulary may be applied. In the appendixes are given tables of the meanings of prepositions in composition, and of the common terminations of words; exercises on forms; and rules for translation.

TELEGRAPHING TO AND FROM RAILWAY-TRAINS: DUPLEX TELEPHONY. By Dr. A. M. ROSEBRUGH. Pp. 11.

THESE are two papers which were read before the Canadian Institute, discussing the question of the priority of invention of the two processes named. Both inventions are claimed by the author for Canada.

PUBLICATIONS RECEIVED.

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Alcott, A. N. The Problem of Fellowship in Religion. A Study of the Present Unitarian Situation. Pp. 38.

Currier, Andrew F., M. D. Some Considerations concerning Cancer of the Uterus. New York: Pp. 17.

United States Bureau of Statistics. Quarterly Report to December 31, 1886. Washington: Government Printing-Office. Pp. 80.

Kellogg, E. L., & Co., New York. The Best One Hundred Books. Pp. 68. 20 cents. Books for Young People. Pp. 20.

Harrower, Henry D. Captain Glazier and his Lake. New York: Ivison, Blakeman & Co. Pp. 58.

Chaillé, Sanford E., Tulane University, Louisiana. Abuse of Alcoholics by the Healthy. Pp. 36.

Marsh, Professor O. C. American Jurassic Mammals. Pp. 20, with Four Plates.

Meigs, Joe V. The Meigs Elevated Railway System. Boston. Pp. 182.

Snow, Marshall S. The City Government of St. Louis. Baltimore: N. Murray. Pp. 40. 25 cents.

Adams, Herbert B. American Historical Association. Report of the Proceedings, Third Annual Meeting. 1886. New York: G. P. Putnam's Sons. Pp. 104. $1.

Shufeldt, R. W. The Veterinary Service of the United States Army. Pp. 6. The Camera and Field Ornithology. Pp. 2.

Harrison, J. B. The Latest Studies on Indian Reservations. Philadelphia: Indian Rights Association. Pp. 238. Free to members.

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Yandell, David W., M. D. Doctorate Address at the Semi-Centennial Anniversary of the University of Louisville Medical Department. Pp. 26.

Stowell, T. B., Ph. D. Natural History in Secondary Schools. Pp. 5.

Dubois, Professor A. J. Science and the Spiritual. Bridgeport, Conn.: Bridgeport Scientific Society. Pp. 32.

Agricultural College of Michigan. Feeding Steers of Different Breeds. Pp. 8.

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Stevenson, John J., New York city. The Faults of Southwest Virginia. Pp. 8.

Griswold, W. M., Washington, D. C. The Continuous Index to Periodicals. Bimonthly. March and April, 1887. Sheet. 50 cents a year.

Allen, Charles A., New Orleans, and others. What is Unitarianism? Pp. 18.

Western Unitarian Association, Chicago. Unitarian Christianity. Pp. 16.

State Reservation at Niagara. Third Annual Report of the Commissioners. Pp. 87.

Crothers, T. D., Hartford, Conn. Cause and Cure of Inebriety. Pp. 11.

Adams, Herbert B. The College of William and Mary. Washington: Government Printing-Office. Pp. 89.

Rush, H. G., New Danville, Pa. The True Doctrine of Orbits. Pp. 188.

Pickering, Edward C. Report of the Photographic Study of Stellar Spectra at Harvard College Observatory. Cambridge, Mass.: John Wilson & Son. Pp. 10, with Plate.

Brewster, Mary Shaw. First Book of Chemistry. New York: D. Appleton & Co. Pp. 144. 77 cents.

Mendenhall, T. C. A Century of Electricity. Boston and New York: Houghton, Mifflin & Co. Pp. 229. $1.25.

Heron-Allen, Edward, and Horsely, Rosamund Brunel. Practical Cheirosophy. New York: G. P. Putnam's Sons. Pp. 125.

Ebers, Georg. The Bride of the Nile. New York: William S. Gottsberger. 2 vols. Pp. 383 and 378.

Rolfe, William J., editor, Tennyson's Enoch Arden, and other Poems. Boston: Ticknor & Co. Pp. 166. 75 cents.

Terry, Samuel Hough. Controlling Sex in Generation. New York: Fowler & Wells Company. Pp. 209.

Peck, William G. Elementary Treatise on Determinants. New York: A. S. Barnes & Co. Pp. 171.

Beal, W. J. Agricultural College of Michigan. Grasses of North America. Published by the author. Pp. 457. $2.50.

"Annual Statistician." 1887. L. P. McCarthy, Editor and Proprietor. San Francisco. Pp. 648.

Crane, Thomas Frederick. Le Romantisme Française. A Selection from the Writers of the French Romantic School. 1824–'48. New York: G. P. Putnam's Sons.

Nicholson, Henry Alleyne. Text-Book of Zoology for Junior Students. Fourth edition, revised and enlarged. New York: D. Appleton & Co. Pp. 888.

Hunt, T. Sterry. A New Basis for Chemistry. Boston: Samuel E. Cassino. Pp. 165.

Andrews, C. C. Brazil. Its Condition and Prospects. New York: D. Appleton & Co. Pp. 352.

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Miller, L. W. The Essentials of Perspective. New York: Charles Scribner's Sons. Pp. 107. $1.50.

Cook, George H. Geological Survey of New Jersey. Annual Report for 1886. Trenton, N. J. Pp. 254.

Bancroft, Hubert Howe. History of Central America. Vol. I, 1501–1530. San Francisco: The History Company. Pp. 704. $5.

POPULAR MISCELLANY.

Elective Studies in American Colleges.—Most of the leading colleges of the country, according to President Barnard, are admitting the elective principle more or less freely into their courses of study. In 1876 Yale College extended its very limited optional list from a minute fraction of the studies of the junior year to about one fourth of those of both junior and senior years. It was enlarged again last year, so that now, out of sixteen hours weekly, seven only are given to prescribed studies in the junior year, and three hours only in the senior. At Princeton one third of the time is given to prescribed studies in the junior year, and three hours in the senior. At Bowdoin about four fifths of the studies are prescribed during both junior and senior years. At the University of Pennsylvania and at Williams College the published announcements indicate that the time of the two later years of the course is about equally divided between prescribed and optional studies. At Rutgers it is allowed to elect one study during the junior and senior years. At Union one third of the time is given to elective studies during the senior year only; but this institution offers also elective courses, a classical and scientific course running through the entire four years. At Brown electives are offered as early as the sophomore year, when they occupy about one fifth of the time. In the same institution, in the junior year, they extend to one third, in the senior to about one half. At Amherst electives cover about one half the time during the second and third of the three terms of the sophomore year, and during the whole of the two later years. In the University of Michigan all the studies are elective after the close of the freshman year; and at Harvard University there are no prescribed studies at all.

Medicines and Digestion.—Dr. Robert G. Eccles lately called the attention of the Brooklyn Pathological Society to the importance of regarding the effect of medicines to be administered upon digestion. "We never stop," he says, "to question the wisdom of pouring into the stomachs of the sick, in the most promiscuous manner, drugs that inhibit or check the production of life- and health-giving peptone. In all chronic diseases, the paramount consideration is that of the patient's nutrition. Where we can not destroy the pathogenic micro-organisms outright, the patient's only hope in the struggle for life lies in the strength of his cells, and their power to triumph over their foes. The most important consideration at those times is digestion. To interfere with it, or check it, is in many cases criminal. When our remedies are incompatible with the gastric juice, the time of taking is likely to be of far more importance than the medicine itself. To weaken patients by the production of artificial mal-nutrition, gives their diseases the advantage over them, when a little more knowledge would have enabled us to aid the vital forces instead of handicapping them." The author described the properties of various remedies in this light, and gave accounts of a large number of experiments which he had made on the subject.

Coal-Tar Colors and Medicines.—Sir Henry Roscoe lately addressed the Royal Institute on "Recent Progress in the Coal-Tar Industry." He said that the hydrocarbons, the essential elements, or skeletons of all organic compounds, are classified as the paraffinoid—the bases of the fats—and the benzenoid hydrocarbons, which give rise to the essences or aromatic bodies, to which all the coal-tar colors, finer perfumes, and anti-pyretic medicines belong. The natural petroleum-oils consist almost entirely of paraffines, and are therefore commercially inapplicable for the production of colors. Coal may by suitable treatment be made to yield oils of a valuable character; and these products are now extensively obtained from the coal-tar which is a residue of the gas-making process, and of coking, when the conditions of temperature are properly managed. Even to enumerate the different chemical compounds which have been prepared during the last thirty years would be a serious task. To illustrate the amount of coloring-power concealed in coal, Sir Henry Roscoe presents tables showing that one pound of the mineral affords magenta enough to color 500 yards of flannel; aurine sufficient for 120 yards of flannel 27 inches wide; vermilline scarlet for 2,560 yards of flannel or alizarin

for 255 yards of Turkey-red cloth. We are at present acquainted, among the derivatives from coal-tar, with about sixteen distinct yellow colors, about twelve oranges, more than thirty reds, about fifteen blues, seven greens, and nine violets; and a number of browns and blacks, besides mixtures of the several chemical compounds, giving rise to an almost infinite number of shades and tones of color. These colors are capable of a rough arrangement according as they are originally derived from one or other of the hydrocarbons contained in the coal-tar. In the class called azo-colors, an azo or nitrogen group replaces the hydrogen in phenols and amido-compounds. They are chiefly bright scarlets, oranges, reds, and yellows, with a few blues and violets. Next in importance to the color industry comes the still more novel discovery of the synthetical production of antipyretic medicine. The initiative in the production of these compounds was given in the discovery by Professor Dewar, in 1881, that quinoline, their basis, is an aromatic compound; from it he obtained aniline. Kairine, the first of the antipyretics in the order of discovery, is manufactured from quinoline. It effects a remarkable lowering of the temperature of the body, which, however, is of much shorter duration than that effected by quinine; but, with the exception of its burning taste, it exerts no such evil effects as are often observed after the administration of large doses of quinine. Antipyrine, the second of these febrifuges, was discovered in 1883. It is made from aniline and aceto-acetic ether. As a febrifuge, it is superior in many respects to kairine and even to quinine. It equals kairine in the certainty of its action, while in its duration it resembles quinine. It is almost tasteless and odorless, is easily soluble in cold water, and takes the form of a white crystalline powder. Its use in medicine is accompanied by no drawback. A third artificial febrifuge is thalline, which is said to be used as an antidote for yellow fever. None of these substances are anti-periodics; and consequently they can not supplant quinine in cases of ague and intermittent fevers. Another group of coal-tar products comprises the artificial aromatic essences. Among these are cumarine, the principle of "new-mown hay"; vanilline, of vanilla, with its derivative vanillen, which is used in preparing "essence of heliotrope"; mirbane, a soap-perfume, and the artificial oil of bitter almonds. The most remarkable of all the coal-tar products is probably saccharine, a substance which surpasses sugar in sweetness. It is not a sugar, for it contains sulphur and nitrogen, nor does it act as a nutriment, but it is non-poisonous, and passes out of the body unchanged.

A Lesson in Practical Anthropology.—Sir C. W. Wilson, in a paper read in the British Association, on "The Wild Tribes of the Soudan," after describing the tribes and their clans, with their divisions and alliances, remarked that it was interesting to observe how thoroughly General Gordon had understood the situation in that region, and at once pointed out the remedy. When he left England, his instructions had been to proceed direct to Suakin, open up communication with the supreme sheik of the Hadendowas who had taken no part in the rebellion, and isolate and crush Osman Digma by raising against him the surrounding tribes, whose sheiks he knew personally. There can be little question that if this policy had been carried out early in 1884, before Sinkat fell and Baker Pasha had been defeated, it would have been successful. But, unfortunately, General Gordon's plans were changed and he proceeded up the Nile. Mr. Hyde Clarke congratulated the section on having had such a paper submitted to them, and said that Sir Charles Wilson had given them a useful exemplification of the value of anthropological studies. They had seen how incidents in the war in the Soudan had turned rather on the knowledge of the men than of the physical features of the country.

Photography of the Stars.—Professor Edward S. Holden has given, in the "Overland Monthly," a popular account of the methods and an estimate of the expectations of stellar photography. The photographic telescope requires special construction and arrangement of the lenses, which differentiate it from ordinary telescopes. If it is set fixed, the image of the star passing across the sensitive plate will leave a "trail," which is the visible representative

of the direction of the star's diurnal motion. If arranged with a driving-clock, so as to follow the star in its motion, it will give a bright point, the photographic image. If we wish to make a picture of the sky, we must register the stars by such points as these. But the trails have various advantages, one of which it that they can not be mistaken for dust or for pin-holes on the plate itself; to avoid the liability to which, the dot-pictures are always repeated. The position of dots in latitude and longitude can be very accurately measured; the latitude of the star can be even better determined from its trail, but its longitude must be determined by special devices. The proper length of exposure for a star of the first magnitude is not more than $\frac{1}{1000}$ of a second. For a star just visible to the naked eye, half a second is enough; for stars of the tenth magnitude, twenty seconds; of the twelfth, two minutes; of the thirteenth, five minutes; of the fourteenth, thirteen minutes; and for the faintest stars visible, an hour and twenty-three minutes.

Fire-Proof Mixtures.—The processes employed to make cloths and woods uninflammable ought to satisfy the following conditions: 1. The preservative substance or mixture should be cheap and easily used. 2. It should not change either the cloths or their colors. 3. It should not be poisonous or corrosive. 4. Cloths or woods impregnated with it should remain uninflammable after having been exposed for a month to a temperature of 100° and over. "La Nature" gives a few of the preparations which seem best to satisfy the different conditions required. A mixture applicable to all light fabrics consists of pure sulphate of ammonia, 8 kilogrammes; pure carbonate of ammonia, 2·5 kilogrammes; boric acid, 3 kilogrammes; pure borax, 2 kilogrammes; starch, 2 kilogrammes, or dextrine, or gelatine; water, 100 kilogrammes. Cloths should be dipped in the solution at a temperature of about 84°, till they have soaked it well up, then partly dried in the air, and afterward dried enough to be ironed like starched clothes. The quantity of starch, dextrine, or gelatine, may be varied according to the degree of stiffness it is desired to give the goods. This mixture is good for ball-dresses. A quart of it will serve for the preparation of about sixteen yards of goods. A mixture applicable to canvas that is already painted and to mounted scenery, to woodwork, furniture, curtains, bedclothes, cradles, doors, and windows, and which can be mixed with dyes, consists of sal-ammoniac, 15 kilogrammes; boric acid, 5 kilogrammes; glue, 50 kilogrammes; gelatine, 1·5 kilogramme; water, 100 kilogrammes, with lime enough to give the proper consistency. It should be employed at a temperature of from 122° to 140°. The pieces may be dipped into it or painted with it. In case of decorations already painted it is enough to whitewash the backs of the canvases, and the frames on which they are hung, with the preparation. A kilogramme of it will paint five square metres of surfaces. A mixture applicable to heavier canvases, cordage, straw-work, wood, and carpentery, consists of sal-ammoniac, 15 kilogrammes; boric acid, 6 kilogrammes; borax, 5 kilogrammes; water, 100 kilogrammes. It is used at a temperature of 212°. The immersion should continue fifteen or twenty minutes, after which the piece should be aired and then dried. Another mixture is applicable to plain or printed papers. It consists of sulphate of ammonia, 8 kilogrammes; boric acid, 3 kilogrammes; borax, 2 kilogrammes; and water, 100 kilogrammes. It is used at a temperature of 122°. To resolve the problem completely—that is to reduce the action of heat on combustible articles to a simple calcination and render them uninflammable, and consequently incapable of starting or supporting a fire—the compositions should protect the fibers of the cloth or wood from contact with the air during the whole continuance of the heat; and the combustible gases disengaged by the heat should be mixed with so strong a portion of other, incombustible gases as to be no longer inflammable. Therefore, the cloth or the wood should be painted with a very fusible substance which, on the first impression of heat, will cover the surface of the fibers, adhere to them, and prevent the contact of the air. Salts that crumble under the action of heat, or of long-continued dryness, those that are hard to melt, efflorescing and hygrometric substances, are, therefore, not the most suitable for these

applications. Borax and boric acid, which are included in the four receipts here given, are very fusible, and are not changed by heat, but only by an excess of moisture in the air, and well fulfill the first condition. Hydrochlorate, carbonate, and sulphate of ammonia readily give off incombustible gases, which have also the positive quality of extinguishing combustion, and thus admirably fulfill the other condition. Hence the compositions recommended possess all the desired qualities. They have also responded satisfactorily to varied tests of experiment.

A New African Region.—The Rev. David Asante, a native missionary of the Basle Gold Coast mission, Africa, recently visited during a journey of exploration the hill-country of Booso, where he says the temperature is cool, rains are frequent, and rivulets numerous. The country is thinly peopled by a population subject to goitre and extremely dirty, whose children and bachelors wear no clothing. Wives, being harder to get—by the process of wooing and winning their consent—than in most African countries are treated well. The fetich-worship is less subtile than on the coast, but the poison-ordeal is frequently resorted to, and accounts for the small population. When a person dies, a whole village sometimes submits to take an infusion of a poisonous bark. Quarrels are settled by resorting to the same dangerous arbiter, thefts are discovered by it, babies who cry much are made to swallow the infusion to prevent their growing up wicked, and parents who lose several children in succession take it in order that the cause of their affliction may be discovered.

Petroleum Products as Fuel.—The residues of the distillation of petroleum have been employed in the Caucasus for several years as a combustible, and have appreciated from having no value in 1874 till they command a price six times higher than crude naphtha, which is now employed as a cheaper fuel. Naphtha has been considered dangerous on account of its explosive qualities, but it has been found that they disappear when the liquid has been exposed to the air for a few days till it has lost its volatile constituents, which compose about fifteen per cent of its substance. Crude naphtha, right from the springs, is burned in the locomotive-furnaces of the Balachanskoi railroad, and there are no accidents. Naphtha is the fuel that develops the greatest quantity of heat, and it also possesses the great advantage of not containing sulphur or other injurious substances. Ninety per cent of the theoretic calorific power can be realized from it, while not more than sixty per cent can be got from solid combustibles. In 1859, doubts were expressed in Russia as to whether petroleum could be used as a combustible; now it is employed exclusively on all the ships in the Caspian Sea, and only half as much of it is required as used to be consumed of coal. The maximum force to be obtained from petroleum is equivalent to two and a half times what coal will furnish; and experiments on the railroad from Baku to Balachan show that a given weight of naphtha will take the place of eight and a half times the weight of wood, although the theoretically calculated difference in calorific power is only as three to one. Petroleum is very conveniently introduced into the furnaces of locomotives with the injectors that are used; the combustion is very easily regulated, and the furnaces last well in the absence of sulphur, while no smoke, sparks, or ashes, are emitted.

Make Room for City Children.—Dr. James B. Russell, health-officer of Glasgow, while he admits that the moral delinquencies of parents, and particularly drunkenness, are important factors to the death-rate of children in cities, insists that too much influence should not be attributed to them. The child of sober, industrious parents, in a city of good sanitary conditions, still lacks room for his complete well-being. The element of space comprehends all the physical conditions of health so completely that the name density is recognized by vital statisticians as the best standard of comparative measurement. Then, as the child grows up, comes the natural desire for play and exercise, which is essential for health and growth. Pent up as city children are, their play becomes in great part mischief. The prevailing characteristics of children's play correspond with the manners, habits, and occu-

pations of the adult population; thus, city children may very often be seen playing at being drunk, or at policemen and thieves, and at fighting. Nothing can be more pitiful than this compulsory perversion of a natural instinct into unwholesome ways. Among the best methods of recruiting city children, the author recommends the system of holiday "colonies," which is in vogue in several European countries. Selected, poor, weakly children, between the ages of seven and fourteen, are sent in colonies of from ten to forty each, under teachers, and the month constituting the school holiday is spent at farm-houses or school-houses in the open country. The improvement in health from these outings has been proved not to be temporary. Provisions for a similar purpose in some of the cities of the United States are commended. The laying out of cities needs to be modified with reference to the requirements of children. Wherever the element of space is involved in any proposed legislation, let the people support that which will give them the most space about their dwellings. They would save increased taxation in doctors' bills and burial expenses. They should remember that the most useful open spaces are those which are close to their houses. Distant parks are not substitutes for the occasional simple play-ground in the heart of the city. Both together form a provision for the young children as well as for the adults.

The Great Inland Depression of Brazil.—It is interesting, says Mr. J. W. Wells, in a paper on "The Physical Geography of Brazil," to note the great depression that extends through the center of the South American Continent, practically similar to what exists in the North American. A canoe can be navigated from the Rio Orinoco to the Rio Negro, thence to the Amazons, then up the Rios Madeira, Mamoré, Guaporé, and Alegré, where it will not be more than five or six hundred feet above the sea. It can then be hauled across a low, grassy flat, as is often done, to the Rio Agoapehy, and then descend by the Rio Jauru and Rio Paraguay to Buenos Ayres. The distance from the Amazons to the Plate by this route is about twenty-five hundred miles, of which sixteen hundred and fifty miles have already been traversed by steamers, leaving eight hundred and fifty miles to be navigated. But it must not be inferred that the whole of this route offers an almost uninterrupted course of navigable rivers; on the contrary, the remaining eight hundred and fifty miles that have not been explored by steamers, not only contain insurmountable obstacles to the passage of even the lightest-draught steamer, but in many places to even the ascent of a canoe. Yet this route will most probably be, in the more or less remote future, the main line of internal communication. By far the greater part of the lands of this natural way are as undeveloped as the Congo of Africa. A connection also exists between the Rio San Francisco and the Rio Tocantins. A canoe can leave the former river and go up the Rios Grande, Preto, and Sapão. The source of the last river is in a beautiful lake in a valley surrounded by fortress-looking table-topped hills; the margins of the lake are bordered by groves of grand Burity palms; on the west the lake drains out into a quick-flowing, considerable stream, the Rio Diego, joins a Rio Preto, and thence onward by the Rio do Sonno to the Tocantins. This journey could be made without once taking the canoe out of the water, except to descend with safety a few rough stretches on the western outlet of the lake.

The Gapes in Chickens.—Dr. H. D. Walker has contributed to the "Bulletin" of the Buffalo Society of Natural Sciences the result of the special investigations which he has made to determine the origin of the gape-worm (*Syngamus trachealis*) of fowls. He believes it to be a parasite of the earth-worm (*Lumbricus terrestris*). Taking the opportunity of a prevalence of the gapes among the chickens, in 1883, and acting under the advice of Dr. Leidy, he sought for the *Syngamus* in the embryonic or larval condition, in some intermediate part. This might, he thought, be the earth-worm, the sow-bug (*Oniscus asellus*), or the garden-slug, all of which were found around the infected coops; while the coops that suffered most were near a bare spot of ground which was full of earth-worms. Parasites were found in the earth-worms and in the slugs. The three animals were fed separately to differ-

ent chicks. No significant effect followed the feeding with slugs or sow-bugs, but the chicks fed with earth-worms developed symptoms of gapes. Experiments were made in artificial culture, and are described in the author's paper. For prevention of gapes, Dr. Walker recommends keeping the chickens away from the ground by putting them on floors, and destroying the earth-worm and its parasite by some preparation fatal to both, such as common salt; asafœtida and garlic, which have been relied upon to cure or prevent gapes, had no effect upon the *Syngamus*.

Dr. Bickerton's Experiments in Color-Blindness.—T. H. Bickerton, of the Royal Ophthalmic Hospital, Moorfields, has recorded the results of his personal examinations of 5,087 subjects, during five years, for color-blindness. Holmgren's tests were used. Of 3,087 men and boys tested, 179 failed at the first test (a very pale, pure green), either by omitting green, or by putting in some other color. Of these, 74 passed successfully the remaining tests, and were considered to have but a very slight chromatic defect, which might be disregarded. Rejecting these, there were 105 cases of color-blindness, or 3·40 per cent of the whole number. Of 1,841 women and girls examined, 3 only, or 0·162 per cent, were to a greater or less extent affected, and of these one so slightly affected that it was cast out, leaving 2 pronounced cases, or 0·108 per cent. Sixty-four male lunatics afforded 1 complete and 1 incomplete case, while 95 female lunatics were all correct. The social status of these and other persons examined varied from the lowest to the highest, and the ages ranged from five years upward. A large majority of them were under twenty-one. Besides those included under the head of very slightly color-blind, there were others whose color-perception was feeble. Among the lower social grades, as represented by the children in orphanages and reformatories, a considerable number made mistakes in the examinations, and these errors were made not only by those of dullish intellects, but also by those who, according to their mistresses, were sharp girls. Cases of this kind were retested after some months' tuition in colors, and in most instances, where ignorance was suspected, the second trial proved the correctness of that conclusion; but there were others who, although they fulfilled the test, did it with the utmost difficulty. Of the 105 cases of color-blindness, Dr. Bickerton further remarks: "Not one so affected was aware of the defect, and a number of them do not believe it to this day. It may seem curious that people who can not distinguish as different colors red, green, and brown, and in some few cases blue and yellow also, do not themselves discover their peculiarity in their vision for colors. Yet, strange as it may be, so it is, and you will find it exceptional for a color-blind to realize in the first instance the defect himself."

Effect of Climatic Changes on Species.—Any theory of the distribution of species, to be acceptable, must take account of the great gaps which appear in the extension of many kinds. Mr. Edward Forbes and many other modern botanists believe that the question is one of changes of climate; or that the climatic variations of the past are reflected in the fauna and flora of the present. Their views are partially confirmed by the observations which Professor A. Blytt, of the University of Christiania, has made of the climatological relations and the distribution of plants in Norway. Nearly all the climatological lines there run more or less in the shape of the coast, so that the climates are ranged in bands, the changes being observed as one goes from the interior toward the sea, or *vice versa*. In keeping with the same are the variations of the flora. The plants may be divided into groups, wherein the species belonging to the same group have a somewhat similar extension, while each of the groups is confined to special climatological conditions, and is found only in those parts where the conditions corresponding with its nature prevail. The flora is generally monotonous; but there are certain places dependent partly, perhaps, on the character of the soil, but as much upon exposure to the sun and protection from the changeableness of the coast climate, where a rich vegetation may be found. The flora is destitute of peculiarly characteristic species, because it has come to the country by immigration after the Glacial period, from other countries which were

free from ice at that time. This immigration must have taken place during repeated changes of climate. "After several thousands of years with a severer climate that favored the immigration and extension of northern and eastern species, other thousands of years followed with a milder climate. During this period fresh immigrants came from the south and southwest, compelling the older flora to retreat. In this manner the climate must have changed several times since the Glacial age, and the distribution of the plants must have changed in accordance therewith. The periods of variation are reflected in the present flora, and it is the former which have led to the great gaps in the extension of coast as well as inland plants. The sunny screes, the slate districts, and the moist coast tracts, are asylums where the different floras have found refuge. In the intermediate parts they have been dislodged by the new-comers. But certain species, being indifferent to the variations, extended constantly, at the expense of others, and this is the reason of the Norwegian flora being so monotonous."

Artificial Digestion.—O. Petersen, of St. Petersburg, has made experiments to ascertain the influence of certain medicines on digestion. The problem he set himself to determine was the time required to digest from 20 to 40 grammes of dried albumen by the aid of 450 centigrammes of a specially prepared artificial gastric fluid. Alcohol in the proportion of five per cent did not hinder digestion, but the process was retarded as the percentage rose, and stopped at ten per cent of alcohol. Antipyrin, in light doses, was without influence, but in larger quantities slightly retarded the action. One or two grammes of bromide or iodide of potassium hindered the process a little. The organic preparations of iron scarcely affected the time required for the digestion, while reduc d iron and the inorganic salts slowed the action, as did also magnesium and sodium sulphates, even in moderate doses. A gramme-dose of chloral hydrate had no slowing effect, though a marked retardation occurred with a dose of a gramme and a half. Chloride of sodium did not retard digestion, even when employed in large doses.

NOTES.

A SERIES of charts, showing the surface temperatures of the Atlantic coast waters, from Maine to Florida, is under preparation by the United States Fish Commission, assisted by the Lighthouse Board and Signal Service. Observations, covering five years in time, have thus far been made at twenty-four lighthouse-stations. The temperatures at the several stations are shown for each year by ten-day means, and in such a manner as to give the isothermal relations of the stations.

IT is said, on the authority of "an American railway engineer," that low temperatures do not decrease the strength of rails, as is commonly supposed, although it is true that accidents are more likely to occur from broken rails in cold weather. This is because, when the ground is frozen hard, it loses its elasticity. Nevertheless, something must yield when the train runs over the road; it is the ground that yields in unfrozen weather; but during a freeze the ground will not yield, and the rail, as being the weakest part of the structure, has to suffer the consequences.

MR. BLANFORD, in his report on the "Administration of the Meteorological Department of India" for 1885–'86, describes the steps which have been taken in the peninsula to discover to what extent forests influence the rainfall. A few observatories have been established in the Ajmere forests, and the results so far have been to show slightly but appreciably higher rainfall in the forests than without. It is admitted that more careful inquiry must be made before any definite conclusions can be drawn. Mr. Blanford points out that M. Woeikoff, in a paper on the subject with special reference to India, essentially supports the view, which he himself regards as probable.

THE Paris Academy of Medicine has been discussing the bad results of mental strain on young persons. A particularly hard bearing of the process was shown upon French girls, twelve thousand of whom are competing for diplomas entitling them to two thousand appointments in government schools.

PROFESSOR SARGENT, Director of the Arnold Arboretum, of Harvard College, estimates that five foreign trees are planted in New England to one native. Yet, of all foreign trees introduced into America, the willow alone, he thinks, has qualities not possessed in a greater degree by some native. The European oak, and the Scotch, Austrian, and Corsican pines all die at about the time when they should be at their prime, and the Norway spruce, at a corresponding age, is decrepit and unsightly.

OYSTER-CULTURE is carried on actively and with yearly increasing returns at Arcachon and Auray in France. Fifteen thousand of the 37,500 acres of the bay of Arcachon are now covered with oyster-beds, which yield 300,000,000 oysters a year. The oyster-beds at Auray, on the coast of Brittany, are less important than those of Arcachon, but they furnished 70,000,000 oysters in 1885.

THE Hon. Carroll D. Wright has reported upon convict-labor that the system of hand-labor under public account is the best. The facts show that the contract system is objectionable though it is the most profitable one, and sustain the complaints that are made against it. Mr. Wright believes that none of the disadvantages arising under the contract system or the piece-price modification of it could be urged against the plan he recommends, and the adoption of it would reduce the effects of convict-labor on rates of wages to a minimum.

ACCORDING to a report from the Internal Revenue Office, there are in the United States 87 oleomargarine-factories, and 266 wholesale and 3,537 retail dealers in that product who paid special taxes in November, December, January, and February last. During the same months, 12,645,740 pounds of oleomargarine were manufactured, and 152,797 pounds were exported.

THE jubilee of Professor Otto Struve was recently celebrated at the Pulkova Observatory, and was honored by the attendance of many delegates from learned societies and scientific institutions.

IT is related, as among the incidents of the Charleston earthquake, that a young girl who had lost her power of speech from infancy, through severe illness, found it suddenly restored in the terror of the shock. Her first use of the recovered faculty was to scream for fear; but, finding she was able to scream, it took but a step to discover that she could also frame words.

IF the stories that are told are true, the negroes at Charleston showed during the earthquake how the power of old habits would cling to them, notwithstanding the great changes that have taken place in their condition. After having been trained for twenty years in the cultivation of self-reliance and the recognition of their parity with the whites, it is said that, when the earthquake came, next to their dependence on the Deity was conspicuous the trust they put in the white people; and, whenever they caught sight of a white face in the darkness and confusion, "they would turn to it as to that of an angel."

THE tenth annual meeting of the American Society of Microscopists will be held in Pittsburg, Pennsylvania, beginning August 30th.

PRESIDENT HARRINGTON, of the Ottawa Field Naturalists' Club, has suggested a test of what we really know about objects with which we imagine ourselves well acquainted. "Sit down with paper and pen," he says, "and try how much you can write about some species with which you are familiar, and you will probably be surprised to find how little there is regarding it of which you are entirely certain. Unless your memory for details is much better than mine, I fear your history will be far from exhaustive. It is easy to believe that you are fully acquainted with a certain form, that you know where and when it appears, and its manner of life and reproduction, but when you attempt to record these, doubts begin to flit through your mind, and your knowledge seems less assured."

WE noticed some months ago that Captain Willard Glazier claimed that he had discovered in 1881 the true source of the Mississippi River in a lake, hitherto unexplored, a short distance above Itasca Lake, to which he gave his own name. The validity of the discovery was disputed; the Minnesota Historical Society took it up for examination; and its report by the Hon. James H. Baker demonstrates that Captain Glazier's claim is of the most fraudulent character. The lake, the true name of which is Elk Lake, is not new, but was known to Schoolcraft and Nicollet, was marked on their maps, and has been marked upon every map of respectable pretensions since 1832. Mr. Henry D. Harrower has also established the same facts in a pamphlet published by Ivison, Blakeman & Co., in which he shows by parallel columns that Captain Glazier stole a considerable part of his narrative bodily from Schoolcraft. The reports afford a convincing exposure of an attempted imposture, which was as silly as it was impudent.

IT has been observed in Ottawa, Canada, that the introduction of the electric light in street illumination has facilitated the collection of entomological specimens, particularly of rare species, as insects of all kinds are attracted to the lamps in large numbers.

OBITUARY NOTES.

DR. GROTHE, of the Polytechnical School at Delft, died on the 10th of February, in the eighty-first year of his age.

M. THOLLON, astronomer at the observatory in Nice, died April 8th, after a long illness, at the age of fifty years. His name was associated with many important discoveries in spectroscopy, the most notable of which, perhaps, was that of the means of distinguishing between telluric and solar rays.